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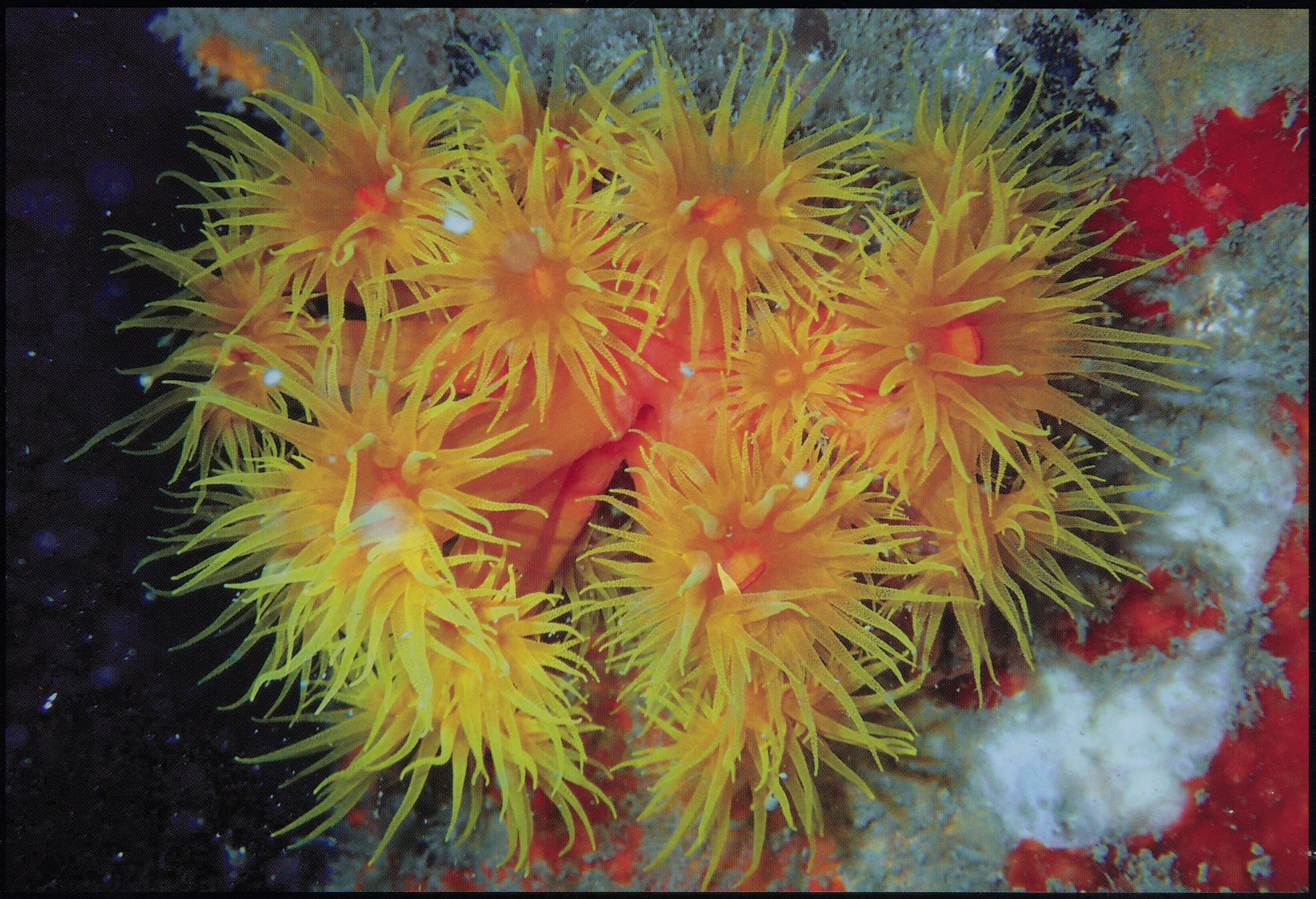

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Cover Photograph: Orange Cup Coral *Tubastraea coccinea* by Shakti Vel

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Editorial

Species Guardians and Species Champions: Is the Indian corporate world listening?

BirdLife International, perhaps the largest conservation organization in the world with Partners and Affiliates in 120 countries (BNHS is BirdLife Partner in India) has initiated a novel programme called Species Guardians and Species Champions. It is succinctly displayed on their website: "The most threatened bird species often require direct species-specific interventions in order to improve their status. BirdLife International's Preventing Extinctions Programme has taken action for over 500 (40%) of the world's threatened bird species since 2008. For many Critically Endangered species, BirdLife has identified Species Guardians (organizations or individuals who are best placed to implement the priority actions for threatened species) and is recruiting Species Champions (companies, institutions, and individuals who provide the funds to support the work of Species Guardians)."

There are many corporates in India, some very well-intentioned, who want to do something for wildlife and environment, but do not know how to go about it. Most of them end up funding school awareness, tree plantation, and watershed programmes, which are good in the long-term but may not help species that are threatened and dying of neglect. Many Critically Endangered species, listed by IUCN, need targeted programmes in the form of *in situ* and *ex situ* conservation.

If you look at the Corporate Social Responsibility section of an annual report of a corporate, all read the same. Happy, neatly dressed children digging pits in a line in a school playground, mugshots of bosses and their wives planting trees, school awareness classes, and children clumsily holding binoculars on a birding trip. Some of the larger corporates fund glamorous tiger-conservation programmes and feel satisfied that they have saved the environment and our natural world. Is this enough to save our wildlife and environment? Can't they help to save non-glamorous, gravely threatened species facing immediate threats of extinction? Can't the corporates adopt a species or a group of species, and habitats and work with conservationists and the government to reverse their decline? Many corporates depend upon the natural resources that come from the habitats where threatened species live. Shouldn't they pay back for the services that biodiversity gives them? These are the questions that come to my mind when I read glossy annual reports of corporates.

I think it is time that corporates get involved in real conservation issues and help in reversing the decline of many Critically Endangered species. India has the misfortune of having one of the highest numbers of globally threatened and near threatened bird species in the world. The IUCN Red List 2014 for birds mentions 174 species in India, about 13 per cent of India's total bird species. For many species, their maximum numbers are present in India and if they become extinct here, they will be globally extinct. But, how many corporates care? The case of vulture decline is too well-known to repeat here. The Critically Endangered status of vultures is shared by Great Indian Bustard, Sociable Lapwing, Bengal Florican, Forest Owlet, White-bellied Heron, and many more. Perhaps less than 50 individuals of White-bellied Heron are left in India and Bhutan. Can't the rich tea estates of Assam and West Bengal come forward to save this magnificent bird of shallow, boulder-strewn streams of East Himalaya? Another bird that can become their conservation mascot is the White-winged Duck. A long time ago, many tea estates were established after cutting down the forests and draining wetlands where this Endangered duck lived for millions of years. Is it not time to do something for this beleaguered bird?

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Rapid industrialization is taking place in the prime habitat of the Great Indian Bustard, resulting in 95–98% decline in its population during the last 50 years. Once widely distributed from Haryana-Punjab in the north to Tamil Nadu in the south, and from Rajasthan-Gujarat in the west to Odisha in the east, the Great Indian Bustard now survives in two viable populations: Naliya landscape in Kachchh and Jaisalmer in Rajasthan. Vast grasslands of Naliya were first taken over by the Indian Air Force in the 1970s, and now the remaining ones are dotted by windmills or converted into agricultural fields. Windmill companies which make so much profit can become GIB Champion in India. For two years we negotiated with a bank that was opening branches in Rajasthan to fund GIB conservation programme, but unsuccessfully. Their initial yes never materialized as their MD was interested only in workshops and limited awareness programmes that give high profile to the bank.

We have many threatened species in immediate danger of extinction. The Government of India does not have funds, or the inclination to go beyond Project Tiger. Hangul in Jammu & Kashmir, Manipur Thamin in Manipur, River Dolphin in the Ganga, endemic frogs of the Western Ghats, endemic hill-stream fishes of Kerala, Mahseer fish of Cauvery river, Dugong of Andaman & Nicobar – the list is endless. All these species can become good conservation emblems of their ecosystems. There are dedicated people (species guardians) working for their protection but most do not have enough resources. For some species, Recovery Plans have been prepared but they are lying in cold storage due to lack of funds. For example, Hangul, the State Animal of Jammu & Kashmir, can be easily revived by *in situ* and *ex situ* protection. A Hangul Conservation Breeding Centre has even been established, but the State Government says that it does not have funds to run it. Imagine a large corporate saving Hangul from extinction by sponsoring a long-term conservation plan. What better publicity and satisfaction could one ask for? Is any corporate group listening?

Asad R. Rahmani

A SIMPLE AND INEXPENSIVE PROTOCOL FOR DNA ISOLATION FROM AVIAN BLOOD

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One of the many challenges encountered during species conservation programmes is genetic management of threatened populations. Declining populations face the threat of genetic drift and/or imbalance in sex ratios, adding to the risk of extinction. The primary step in genetic management of any population is the isolation of DNA from an available tissue sample. Good quality and quantity of DNA, whenever isolated, could be preserved and applied in a number of studies. Collection of blood, which is a very good source of DNA, from birds is possible in conservation programmes. A simple and inexpensive protocol for DNA isolation facilitates processing the blood samples in the field with ease. Commercial kits, though available, are expensive and have limited shelf life. Herein, we report a simple protocol of DNA isolation from avian blood. The protocol did not employ any proteases or organic solvent, making it comparatively inexpensive. This protocol, initially developed for vulture blood, was successfully applied later for other species. The protocol could isolate DNA sufficient for at least 50 amplification reactions. The isolated DNA was found suitable for spectrometry as well as downstream applications like PCR and cloning.

Keywords: DNA isolation, avian blood, simple, inexpensive, vultures

Out of 10,425 species of birds worldwide, 1,375 are threatened with the possibility of extinction, while 971 species of birds are near threatened (IUCN 2015). This situation is alarming for the ecosystem, as many of the threatened species are indicator species or they occupy crucial niches in food chains and food webs, notably the California Condor, Ridgway's Hawk, Walden's Hornbill, and Asian vultures (IUCN 2015). To revive the population of threatened bird and mammalian species, a number of conservation initiatives have been undertaken by various organizations. One of the many challenges faced by the *ex situ* and *in situ* conservation programmes is genetic management of the populations of threatened species. Population declines are responsible for creating genetic bottlenecks (resulting in genetic drift) and/or imbalance in the sex ratio, which further threaten the species (Belovsky *et al.* 1999; Breininger *et al.* 1999; Fischer and Stöcklin 1997; Newmark 1995). Hence, one of the most important areas of study, which emerged recently, has been the application of population genetics and molecular tools for assisting conservation programmes. Studies like analysis of the genetic diversity of a population (Banhos *et al.* 2008; Geyer *et al.* 1993; Haig *et al.* 1990; Miller *et al.* 1994), molecular sexing (Chou *et al.* 2010; Ghorpade *et al.* 2012), and phylogenetics (Arshad *et al.* 2009; Geyer *et al.* 1993) have gained crucial importance in the conservation of rare and endangered species.

The first step in any genetic study is collection of genetic material. A good quality and quantity of DNA could be preserved over years and could be used in various studies, as well as applications. In conservation breeding programmes, blood collection from live as well as dead birds (clotted blood) is possible as birds are held in captivity. However, the absence of a simple and inexpensive protocol for DNA isolation from the collected blood has been a major impediment. A number of kit-based protocols are available for DNA isolation from avian blood. However, these kits are expensive, have a short shelf life, and are practical only if a large number of samples need to be processed. Moreover, the use of kits might require specific equipment for sample processing, which may not be available in basic laboratories. Other published protocols (Bailes *et al.* 2007; Khosravinia *et al.* 2007) require proteases, besides being labour intensive, and often time consuming. One of the simple and inexpensive protocols initially developed for human blood samples that entailed 30-min treatment of samples with 0.2 M NaOH had been used for extraction of genomic DNA from avian blood (Rudbeck and Dissing 1998), which isolated genomic DNA sufficient for 50 to 100 amplification reactions. A similar approach had been used for extraction of genomic

DNA from feathers as a potential source (Malago *et al.* 2002). However, alkaline treatment denatures the DNA, leaving it unsuitable for quantification by sensitive-dye-fluorescence or analysis by restriction endonuclease digestion (Bailes *et al.* 2007). Besides, sample processing could differ when the standard protocols available for isolation of genomic DNA from mammalian blood are applied for isolating genomic DNA from avian blood due to presence of nucleated RBCs in birds (Grimberg *et al.* 1989; Helms 2002; Sambrook *et al.* 1989; Yokota *et al.* 1998).

We report a simple and inexpensive protocol for isolation of genomic DNA from avian blood. This protocol was developed at the BNHS-Vulture Conservation Breeding Centre (VCBC), Pinjore, Haryana, and School of Science, University of NMIMS, Mumbai, Maharashtra. The BNHS-VCBC at Pinjore is the largest conservation breeding centre for any bird in Asia and houses more than 200 vultures belonging to three Critically Endangered *Gyps* species, namely Oriental White-backed Vulture *Gyps bengalensis*, Long-billed Vulture *Gyps indicus* and Slender-billed Vulture *Gyps tenuirostris*. The reported protocol was initially developed for isolation of DNA from the vultures at VCBC and was later applied for other species.

Abbreviations used in the text

DNA – Deoxyribonucleic Acid, PCR – Polymerase Chain Reaction, IUCN – International Union for Conservation of Nature and Natural Resources, NaOH – Sodium hydroxide, RBCs – Red Blood Cells, EDTA – Ethylenediaminetetraacetic acid, NaCl – Sodium chloride, CHD – Chromodomain Helicase-DNA-binding protein gene, NCBI – National Centre for Biotechnology Information, SDS – Sodium Dodecyl Sulfate, TE – Tris EDTA.

MATERIAL AND METHODS

Sample Collection

Blood samples from Slender-billed Vulture *Gyps tenuirostris*, Oriental White-backed Vulture *G. bengalensis*, Long-billed Vulture *G. indicus*, and Himalayan Vulture *G. himalayensis* were collected during routine health checks at the BNHS-VCBC, Pinjore, in September 2012. Blood from injured Cinereous Vultures *Aegypius monachus* was also collected during the same period. Blood sample from Black Kite *Milvus migrans govinda* was collected from Bombay Veterinary College, Parel, Mumbai, in January 2010. Blood sample from Domestic Fowl *Gallus gallus* was collected from a local slaughterhouse in Pinjore, Haryana, in September 2012. The samples were collected in 4 ml EDTA vials and were stored at 4 °C until DNA isolation.

Protocol of DNA isolation from avian blood

In a 2.0 ml microfuge tube, 3–4 µl of avian blood was added to 1.5 ml of buffer A (0.005 M Tris-Cl, 0.3% Triton X-100, 0.002 M EDTA). The contents were mixed by gently inverting the tube and the resulting solution was left undisturbed for 5–7 min at room temperature. The tube was then centrifuged for 2–3 min at 1,250x g in a fixed angled rotor at room temperature. To the resulting pellet, 400 µl of reagent B (0.2 M Sodium acetate and 0.002 M EDTA) was added. The content was then mixed by shaking the tubes vigorously to form a homogenous solution. 40 µl of 10% SDS was added to this homogenous solution and the contents of the tube were mixed gently by inverting the tube a few times. The resultant solution was then kept at 60 °C for one hour in a water bath. After an hour, the tube was removed and allowed to cool at room temperature. Then, 620 µl of 5.3 M NaCl was added and the contents were mixed well by repetitive pipetting (15–20 times) till a milky white homogenous solution was formed. The tube was then centrifuged at 1,000x g for 10 min at room temperature. Resulting supernatant was carefully transferred into a fresh 2.0 ml microfuge tube and 800 µl of ice-cold isopropanol was added to it; the contents were mixed well by inverting the tube and left undisturbed at 0–4 °C for 15–20 min and centrifuged for 6 min at 5,000x g, the supernatant was discarded. The resulting DNA pellet was washed with 1 ml of 70% ethanol and then centrifuged at 5,000x g for 6 min. Finally, the DNA pellet was dried at room temperature and resuspended in 100 µl of 1x TE (0.01 M Tris-Cl pH-8.0, 0.001 M EDTA pH-8.0) buffer pH 8.0.

The protocol did not employ any proteases or organic solvents like phenol. Also, all the centrifugation steps were carried out at room temperature.

Using this protocol, DNA was isolated from Slender-billed Vulture (male and female individuals), Oriental White-backed Vulture, Long-billed Vulture, Cinereous Vulture, Himalayan Vulture, Black Kite, and Domestic Fowl. Qualitative and quantitative assessment of the isolated DNA was carried out using 1% agarose gel electrophoresis, spectrometry and PCR, as well as cloning and characterization of CHD gene (Kulkarni *et al.* 2014). Spectrometry was carried out using the Nanodrop 1000 spectrophotometer and ND 1000 V3.7.1 software.

PCR amplification of CHD gene from *Gyps tenuirostris* using *P2/P8* primers

The partial CHD-*W* and CHD-*Z* sequences were amplified using the *P2/P8* primer pair (Griffiths *et al.* 1998). Genomic DNA isolated from known-sex individuals of a

male (A63) and a female (A60) Slender-billed Vulture were used in PCR to amplify the CHD-*W* and CHD-*Z* sequences. PCR was carried out in 25 µl reaction volume, consisting of 1x reaction buffer with 2 mM Magnesium chloride, 0.2 mM of each dNTP, 100 ng genomic DNA, 0.4 µM of each *P2* (Forward 5'-TCTGCATCGCTAAATCCTTT-3') and *P8* (Reverse 5'-CTCCCAAGGTGAGRAAYTG-3') primers and 1 U *PfuUltra* II fusion HS DNA polymerase. Negative control with no genomic DNA was also run with every PCR. Thermal cycling conditions were set as: initial denaturation at 94 °C for 4 min, followed by five cycles of 94 °C for 30 s, 49 °C for 30 s, 72 °C for 30 s, and 49 cycles of 94 °C for 30 s, 48 °C for 20 s, 72 °C for 20 s, with final extension at 72 °C for 5 min. The obtained PCR products were separated on 2% agarose gel and were then purified using QIA quick gel extraction kit for subsequent applications, wherein cloning of the purified PCR products in pJET1.2 vector and the sequencing of the recombinant plasmids encoding CHD-*W* and CHD-*Z* amplicons was carried out (Kulkarni *et al.* 2014).

RESULTS

Purity assessment and quantification of the isolated DNA

The purity of isolated DNA was studied by subjecting it to gel electrophoresis and spectrometry. It is evident from the gel electrophoresis pattern depicted in Fig. 1 that the isolated DNA was intact as no fragmentation or smearing of DNA was observed on the gels. The concentration of the DNA isolated from the mentioned blood samples of two Slender-billed Vultures and five individuals each of White-backed Vulture, Long-billed Vulture, Cinereous Vulture, Himalayan Vulture and Black Kite was found to be in the range of 110.0 to 360.8 ng/µl and the 260nm/280nm ratio for all the samples was found to be in the range 1.87 to 1.93.

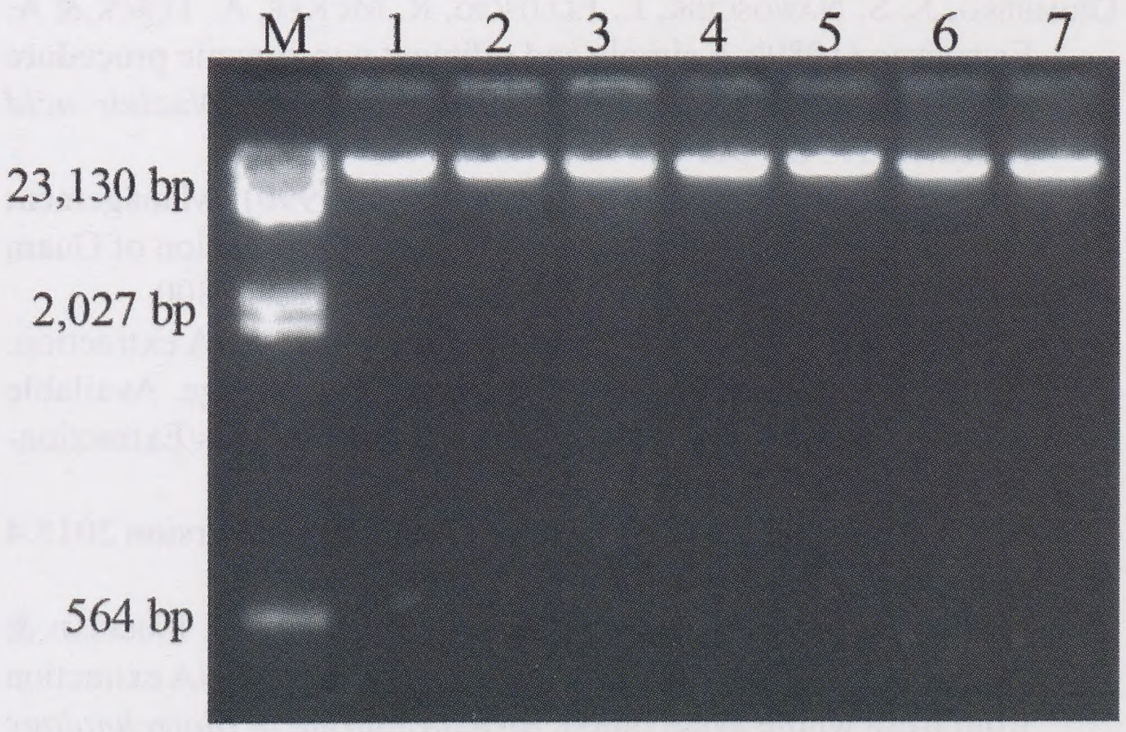

Fig. 1: Gel electrophoresis of DNA isolated from various avian species in 1% agarose (M: λ-DNA/HindIII digest marker, lanes 1–7 represent genomic DNA isolated from: Oriental White-backed Vulture, Long-billed Vulture, Slender-billed Vulture, Himalayan Vulture, Cinereous Vulture, Black Kite and Domestic Fowl, respectively

Amplification of CHD-*W* and CHD-*Z* sequences by *P2/P8* PCR

Amplification of the CHD-*W* and CHD-*Z* sequences of Slender-billed Vulture was carried out using *P2/P8* primer pair. A total of 2 samples, i.e. a male and a female Slender-billed Vulture were processed. Both the individuals showed a band of 400 bp on 2% agarose gel (Fig. 2). Amplification of CHD alleles from the isolated DNA and its further use in cloning and sequence characterization was successfully carried out.

DISCUSSION

The DNA isolation protocol was derived from two different approaches used for isolation of genomic DNA from mammalian blood samples (Helms 2002; Sambrook *et al.* 1989). These approaches used either proteases (e.g., proteinase K) and/or organic solvents (e.g., phenol:chloroform) for digestion of cellular proteins and separation of nucleic acids or both. However, the developed protocol employed detergents for lysis of cellular proteins and saturated NaCl for purifying the DNA. Unlike the known DNA isolation protocol, no proteases or organic solvents, like phenol were employed in this study; these reagents are expensive and require storage at -20 °C and 4 °C, respectively. Also, all the centrifugation steps in the present protocol can be carried out at room temperature. Thus, the new protocol is comparatively inexpensive and can be easily used in a laboratory with basic facilities. Further, as no alkaline treatment was employed, the isolated DNA can be used for quantification by sensitive intercalating-dye-fluorescence or analysis by restriction endonuclease digestion (Bailes *et al.* 2007). Furthermore, avoiding use of potentially hazardous

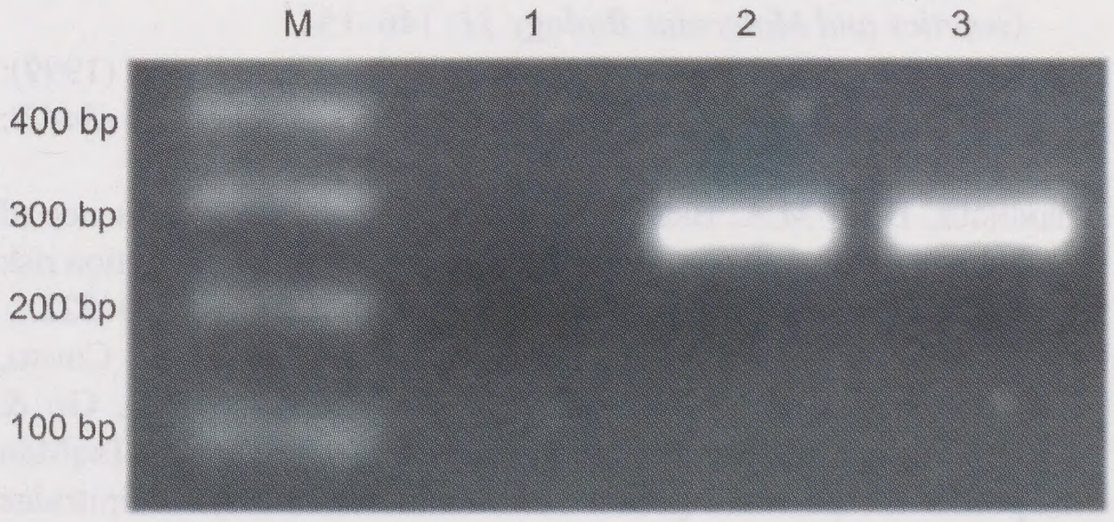

Fig. 2: Gel electrophoresis of P2/P8 PCR amplicons of CHD gene of Slender-billed Vulture in 2% agarose gel (M: 100 bp DNA ladder, lanes 1–3 represent PCR amplicon of CHD gene from samples; no template control, Slender-billed Vulture male (A63) and Slender-billed Vulture female (A60)

organic solvents like phenol make the approach simple and eco-friendly. Since steps like separation of aqueous phase or spooling out the separated DNA were eliminated, the protocol proved easier to perform as compared to routine laboratory protocols (Sambrook *et al.* 1989).

The results of the qualitative and quantitative assessment using spectrometry analysis and agarose gel electrophoresis also proved the efficacy of the protocol. DNA isolated from all samples was within acceptable purity and the quantification results proved that the least concentration of isolated DNA was also good enough for performing at least 50 amplification reactions.

The PCR products obtained for CHD-*Z* (386bp) and CHD-*W* (389bp) from Slender-billed Vulture samples were confirmed by sequence analysis after cloning them. The sequences corresponding to CHD-*W* and CHD-*Z* genes of the Slender-billed Vulture were submitted to NCBI GenBank and were assigned NCBI accession numbers KF977833 and KF977832, respectively. Since the isolated DNA from two Slender-billed Vulture samples (known male and female) was successfully used in the cloning and characterization of CHD-*W* and CHD-*Z* sequences (Kulkarni *et al.* 2014), it is inferred that the DNA isolated by the protocol established in this study is of high quality and can be employed in downstream applications without further purification.

Conservation Implications

The findings of the study revealed a simple and inexpensive DNA isolation protocol for processing avian blood. This protocol could assist in genomic studies at the increasing number of Conservation Breeding Programmes of birds across the world where only basic laboratory facilities are available. Further applications of this protocol may include isolating DNA from bird carcasses, which would allow the researchers to collect additional information while investigating the causes of mortality in birds.

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DOES CAPTIVITY AFFECT THE AEROBIC CULTURABLE GASTROINTESTINAL AND RESPIRATORY MICROFLORA OF THE INDIAN *GYPS* VULTURES?

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Long-term captivity is known to alter the microflora of animals. This alteration in microflora could be because of diet or the environment, and might affect the normal physiological functions of the animal. This study was conducted to assess whether captivity had altered the microflora of the critically endangered *Gyps* vultures of three species – Long-billed Vulture, White-rumped Vulture, and Slender-billed Vulture – at the BNHS-Vulture Conservation Breeding Centre, Pinjore, Haryana. Cloacal and choanal swabs from 17 captive vultures, hatched at the Centre, were collected and analyzed for aerobic culturable bacteria. The birds were hatched in captivity and were in captivity since hatching till the time of sampling. Results from these samples were compared with the patterns obtained from 32 wild hatched vultures held in captivity at the centre, with patterns from four free ranging Red-headed Vultures used as control. No significant differences were found between the microflora of the captive and wild hatched vultures held in captivity, thus indicating that captivity had not affected the microflora of the captive hatched vultures. This study is the first of a series of planned studies, to ensure that the captive hatched vultures remain healthy and fit to be released in the wild.

Key words: aerobic culturable bacteria, *Gyps* vultures, Red-headed Vulture, gastrointestinal microflora, respiratory microflora

INTRODUCTION

Gut microflora and its role in studying the ecology and evolution of animals is a burgeoning area of interest (McFall-Ngai *et al.* 2013). However, the studies have been mostly restricted to humans. Recently, scientists have successfully demonstrated the role of gastrointestinal microflora in determining the health of various animals but predominantly humans. Zupancic *et al.* (2012) investigated the gut microflora of individuals linked with obesity and metabolic syndrome and reported 26 bacterial species, which appeared to be linked with metabolic disorders. Ridaura *et al.* (2013) artificially exposed different groups of germ free mice to bacteria, from lean and obese individuals, and observed the mice getting the 'lean' bacteria to stay lean as compared to the mice with 'obese' bacteria, despite both groups receiving the same amount of food.

Studies to identify the normal microflora of animals bred and reared in captivity become important as these help to identify pathogens and control disease. Also, as adverse changes in the normal microflora lead to the development of metabolic disorders, it is important to check whether such changes occur in animals in captivity. Hence, such studies are a valuable contribution to the conservation of the animal species.

Several studies have reported a significant difference between the microflora of wild and captive animals of the same species (Ley *et al.* 2008; Nelson *et al.* 2013; Scupham *et al.* 2008; Uenishi *et al.* 2007; Villers *et al.* 2008; Wienemann *et al.* 2011; Xenoulis *et al.* 2010) and concluded that this difference existed between animals born in the wild and those born in captivity. Dhanasiri *et al.* (2011) documented a decrease in microbial diversity in the Atlantic Cod as the animals entered captivity.

Conservation breeding programmes are important tools for saving species from extinction, but they require keeping birds or animals in captivity for long periods of time. To ensure that captivity does not eventually have an adverse effect on the normal microflora of the animals, comparative studies on the microflora patterns between wild and captive hatched individuals become essential. With such information, it will be possible to determine if any abnormal bacterial prevalence in the captive animals is affecting their health.

A conservation breeding programme was initiated by the Bombay Natural History Society and Forest Department, Haryana, to save three *Gyps* species – White-rumped Vulture *Gyps bengalensis*, Long-billed Vulture *Gyps indicus*, and Slender-billed Vulture *Gyps tenuirostris* – from possible extinction. The populations of these three resident *Gyps* vultures in the Indian subcontinent have declined by over

99% in the past two decades due to diclofenac contamination of domesticated animal carcasses (Green *et al*. 2004; Oaks *et al*. 2004; Prakash *et al*. 2012). Vultures provide an important ecosystem service by feeding on dead animals, thus limiting the multiplication and spread of pathogenic organisms that the carcasses could harbour. The conservation breeding programme was initiated for these species as it was considered to be the most urgent conservation action to save these species from extinction. The founder population was established by bringing wild birds into captivity.

This paper compares the bacterial flora between the vultures hatched in captivity with those hatched in the wild.

MATERIAL AND METHODS

Study area

The study was carried out on three *Gyps* species of vultures, bred in captivity and housed at the BNHS-Vulture Conservation Breeding Centre (VCBC), Pinjore, Haryana, India. The site lies within the normal distribution range for all the three species (Ali and Ripley 1983).

The study animals

The vultures were kept in flocks in near natural conditions in big aviaries (30.48 x 12.19 x 6.10 m). They were fed on skinned goat carcasses. All the birds studied had hatched in captivity to parents caught from the wild, while the wild hatched birds had hatched in the wild to free ranging parents. All the sampled birds were fully grown and were not dependent on parents for food.

Red-headed Vulture *Sarcogyps calvus* is another vulture species resident in the Indian subcontinent. The feeding habits of this species are similar to the *Gyps* vultures and it feeds on carcasses often with *Gyps* vultures.

The diet of the *Gyps* and Red-headed vultures mostly consists of carrion. In the wild, they feed on the carcasses of a number of large vertebrates, especially large ungulates both domestic and wild. The captive vultures sampled during the study were fed only on skinned goat and sheep carcasses. *Gyps* vultures are adapted to consume the soft tissues such as muscle and visceral organs of animal carcasses, while the Red-headed vulture, in addition to feeding on the muscle and internal organs, can also feed on the tough outer skin of the carcass (Ali and Ripley 1983).

Processing of samples

Cloacal and choanal swabs of 6 randomly selected White-rumped vultures, 6 Long-billed vultures and 5 Slender-billed vultures housed at the VCBC were collected during the annual health check in October 2011. Cloacal and choanal swabs of four free ranging Red-headed vultures were collected when they were captured for application of PTTs for satellite telemetry studies conducted between November 2012 and March 2013. The samples were taken in duplicate and were analyzed simultaneously.

In order to get a holistic picture of all the aerobic culturable bacterial types, selective media was not used. Both sets of swabs were inoculated in Soyabean Casein Digest Broth in duplicate, to enrich the bacteria present in the sample. 10 µl of the overnight culture from both the sets was then used to streak onto Nutrient Agar plates, to get isolated colonies of the bacteria in the culture. These plates were observed for different colony types on the basis of their colony characters. The different colony types were isolated for further identification. The method of enrichment and isolation of different species of bacteria was followed as described in Bangert *et al*. (1988), Blanco *et al*. (2006), and Kocijan *et al*. (2009). Preliminary tests to identify the genus and secondary biochemical tests to identify the species of bacteria were followed as described in standard literature (Holt *et al*. 1984; Quinn *et al*. 1994). The secondary biochemical tests employed for the genus and species identification of the isolates are summarized in Table 1.

Table 1: Summary of biochemical tests used for species level identification

Group of organism	Tests applied
Gram negative rods and coccobacilli	Fermentation of sugars glucose, sucrose, maltose, mannitol, xylose, trehalose, and lactose, growth on MacConkey's agar and EMB agar, Oxidase test, nitrate test, indole test, MR test, VP test, Citrate utilization test, Urease test, growth on TSI agar to check for H_2S production.
Gram positive catalase positive cocci	Haemolysis on sheep blood agar, slide coagulase, tube coagulase, growth at 6.5% NaCl, DNase, TNase, Phosphatase, resistance to Novobiocin, fermentation of sugars mannitol and trehalose.
Gram positive catalase negative cocci	Haemolysis on sheep blood agar, fermentation of esculin, bile tolerance, growth at 6.5% NaCl, hydrolysis of hippurate, resistance to Bacitracin, fermentation of sugars Lactose, Mannitol, Trehalose, Sorbitol, and Raffinose.
Gram positive rods	Presence of endospores, presence of volutin granules, motility in semi-solid medium, nitrate reduction test and colony morphology.

Results from these tests were fed into an online bacterial identification system called ABIS (www.tgw1916.net). The identification results using above mentioned software were comparable with the results obtained using standard literature. Isolates requiring further confirmation for species identification were identified by 16s rRNA sequencing. This was done commercially in India.

Analysis

All species of bacteria isolated were grouped into five families according to their biochemical characteristics (namely Enterobacteriaceae, Enterococcaceae, Streptococcaceae, Staphylococaceae, and Bacillaceae). The differences in the microflora between the wild and captive hatched individuals were analyzed using Mann-Whitney *U* tests (Blanco *et al*. 2007; Shringarpure *et al.* 2014). To determine the habitat specificity of the bacteria, that is to check whether the identified bacterial group was more common in the gastrointestinal or the respiratory tract, the prevalence patterns of the bacterial group was compared between the gastrointestinal and respiratory tracts of all captive hatched individuals using Mann-Whitney *U* tests. This was also done to check if the patterns observed were similar to those of wild hatched birds. All analyses were performed using lacostatistical software GraphPad Prism version 5.

RESULTS

Richness and diversity of bacterial species in gastrointestinal and respiratory tracts

Ten culturable bacterial species each were isolated from the gastrointestinal and respiratory tracts of all the captive hatched *Gyps* vultures. Samples from the Red-headed Vulture had six culturable bacterial species in the gastrointestinal tract and three species in the respiratory tract. The various groups of bacteria isolated from gastrointestinal and respiratory tracts across the *Gyps* vulture species are summarized in Table 2 and Table 3 respectively, while bacteria isolated from the Red-headed Vulture are shown in Table 4.

Comparison of bacterial species richness and diversity

Comparison of the richness and diversity of the bacterial families Enterobacteriaceae, Enterococcaceae, Streptococcaceae, Staphylococcaceae, and Bacillaceae between gastrointestinal tract samples of wild and captive hatched birds revealed that the patterns of all the bacterial families were similar between both the vulture groups ($p>0.05$, Mann-Whitney *U* test). Analysis of respiratory tract samples between wild and captive hatched vultures also showed that the microflora between the two vulture groups was similar.

While determining the habitat specificity of the bacteria among the captive *Gyps* vultures, it was found that bacteria belonging to the family Enterobacteriaceae were more prevalent in the gastrointestinal tract ($p=0.0117$, Mann-Whitney *U* test). Bacillaceae were found to be more common ($p=0.0247$, Mann-Whitney *U* test), in the respiratory tract. The gastrointestinal tract samples from the Red-headed Vulture showed Enterobacteriaceae and Enterococcaceae, while the respiratory tract samples showed Staphylococcaceae and Streptococcaceae as the major contributors to its microflora. In the Red-headed vulture, there was only one case each, where the gut showed the presence of Staphylococcaceae and the respiratory tract contained Enterobacteriaceae.

DISCUSSION

The common and rare bacteria encountered in captive hatched vultures were similar to those obtained from the wild hatched ones. In the gastrointestinal tract samples, *Escherichia coli* occurred in over 80% of the bird samples, except for the White-rumped vulture, where it was found in only 67% of the samples. Although similar, the prevalence is much lower than that found in the wild hatched birds, where it was present in over 90% of the samples (Shringarpure *et al.* 2014). There was also a slight difference in the prevalence of enterococcal species, which were present in 70–80% of the samples in wild hatched birds but only in 50–60% of the samples in captive hatched ones. The free ranging Red-headed vulture also showed a high prevalence of these species in the gastrointestinal tract. These species are common inhabitants of the gastrointestinal system of humans and other species of animals, including birds, and are responsible for metabolism of carbohydrates to generate energy, production of vitamin K, immunostimulation, creation of anaerobic conditions to facilitate succession by strict anaerobes and out-competing pathogens (Silva *et al*. 2011). Unlike the captive *Gyps* vultures, which showed some prevalence of staphylococcal and streptococcal species in the gastrointestinal tract, only one Red-headed vulture had staphylococcal species in its gastrointestinal system.

In the respiratory tract samples, organisms from the group Staphylococcaceae, especially *Staphylococcus epidermidis* and *Staphylococcus saprophyticus* were found to be common in the respiratory environment, and were likely members of the normal flora of the respiratory tract. The staphylococcal species were also commonly found in the respiratory tract of the free ranging Red-headed vulture, but unlike the *Gyps* vultures, whose respiratory tract also showed prevalence of enterobacterial species, only one Red-headed vulture had *Escherichia coli* in its respiratory tract.

Table 2: Prevalence of bacterial microflora in the respiratory tract of the three *Gyps* vultures

	Bacterial Species	Vulture species		
		White-rumped (N=6)	Long-billed (N=6)	Slender-billed (N=5)
Bacillaceae	*Bacillus cereus*	33%	17%	60%
Enterobacteriaceae	*Citrobacter freundi*	17%	0%	0%
	Escherichia coli	50%	50%	20%
	Enterobacter asburiae	0%	0%	20%
Enterococcaceae	*Enterococcus durans*	0%	0%	20%
	Enterococcus faecalis	34%	34%	20%
Streptococcaceae	*Streptococcus pneumoniae*	34%	0%	20%
	Staphylococcus pseudintermedius	17%	17%	0%
Staphylococcaceae	*Staphylococcus epidermidis*	34%	67%	0%
	Staphylococcus saprophyticus	17%	50%	40%

*The values represent the percentage of birds tested positive for the bacterial species with one sample per bird

Table 3: Prevalence of bacterial microflora in the gastrointestinal tract of the three *Gyps* vultures

	Bacterial Species	Vulture species		
		White-rumped (N=6)	Long-billed (N=6)	Slender-billed (N=5)
Bacillaceae	*Bacillus cereus*	0%	17%	40%
Enterobacteriaceae	*Escherichia coli*	67%	83%	80%
	Proteus vulgaris	33%	17%	0%
	Salmonella enterica	0%	0%	20%
	Yersinia fredrikseni	33%	17%	0%
Enterococcaceae	*Enterococcus avium*	17%	0%	20%
	Enterococcus faecalis	50%	17%	40%
Streptococcaceae	*Streptococcus pneumoniae*	17%	17%	0%
Staphylococcaceae	*Staphylococcus epidermidis*	50%	34%	40%
	Staphylococcus microti	17%	17%	0%

*The values represent the percentage of birds tested positive for the bacterial species with one sample per bird

The staphylococci are able to colonize the respiratory tract on account of its almost neutral pH (range 7.2–7.4, compared to pH 1–2 in the gastrointestinal tract). Also, these organisms colonize the respiratory tract at an early stage on account of their tissue specificity and out-compete the other bacterial groups for binding sites (Todar 2008). Thus, their major role in the respiratory tract is the prevention of pathogens from the environment from colonizing the respiratory tract.

Bacillus cereus was commonly found in the gastrointestinal tract as well as respiratory tract of the sampled captive hatched vultures. This organism was also commonly found in the wild hatched vultures (Shringarpure *et al.* 2014), as well as in several surveys of bacterial flora in the Turkey vulture (Winsor *et al.* 1981); Egyptian vulture (Blanco *et al.* 2006) and Eurasian Griffon vulture (Kocijan *et al.* 2009), but not in the free ranging Red-headed vulture. *Bacillus cereus* does not appear to have any role in these systems and is probably a transient flora obtained from the environment. The bacteria in the vulture gastrointestinal tract included *Yersinia fredriksenii*, *Salmonella enterica*, *Proteus vulgaris*, and *Staphylococcus microti*. Their rare prevalence and lack of symptoms in the host indicate that these are also transient flora obtained from food (*Salmonella enterica* and *Proteus vulgaris*). Similarly, the rarely encountered bacteria in the respiratory tract such as *Citrobacter freundii*, *Enterobacter asburiae*, and *Staphylococcus pseudintermedius* represent the transient flora of the respiratory tract.

No statistically significant differences were found in the richness and diversity of any of the five families of bacteria between the wild hatched and captive hatched vultures. The

Table 4: Prevalence of bacterial species in the gastrointestinal and respiratory tracts of free ranging Red-headed vulture *Sarcogyps calvus*

	Bacterial species	Cloacal swabs (N=4)	Choanal swabs (N=4)
Enterobacteriaceae	*Citrobacter werkmanii*	25%	0%
	Escherichia coli	75%	25%
	Proteus vulgaris	25%	0%
Enterococcaceae	*Enterococcus avium*	50%	0%
	Enterococcus caccae	25%	0%
Staphylococcaceae	*Staphylococcus capitis*	25%	0%
	Staphylococcus epidermidis	0%	75%
Streptococcaceae	*Streptococcus equi*	0%	50%

*The values represent the percentage of vultures tested positive for each bacterial species with one sample per bird

prevalence of species indicated as normal microflora was slightly low in the captive hatched birds, which needs to be investigated further using more samples. Similarly, visible differences were observed between the pattern of prevalence of bacteria among the gastrointestinal and respiratory tracts of the *Gyps* vultures and the free ranging Red-headed vulture.

CONCLUSION

Not many attempts have been previously made to document the normal microflora of the three critically endangered *Gyps* vultures, either in wild or in captivity. Comparative studies of patterns of microflora between wild hatched and captive hatched vultures were essential to determine whether the birds hatched in captivity were healthy. Conservation breeding programmes are important tools to prevent extinction of species, but they require that the animals are kept in captivity for long periods of time. The differences in the microflora patterns observed between the captive hatched and wild hatched birds might just be due to the difference in diversity of food given to them. The present study is the first report of such a comparative study. From the results, it seems that the present captive management strategies have not significantly altered the microflora of the vultures bred in captivity. The composition of gastrointestinal microflora appears to be determined by the diet, as the organisms isolated from the gastrointestinal system are commonly reported in the animals, which form the food source of the vultures, and captivity has not much role to play. This was possibly because of the existing husbandry and care protocols which ensured that the captive vultures live similarly as they would in the wild. Also, the composition of respiratory microflora appears to be determined by the microbial composition in the environment, and would remain similar whether in wild or in captivity. Such studies need to be continued and built upon further till the duration in captivity of the vultures, to ensure that the patterns are maintained.

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TRACKING THE MOVEMENT PATTERN OF BAR-HEADED GOOSE *ANSER INDICUS* CAPTURED FROM THE GHARANA CONSERVATION RESERVE, INDIA

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Bar-headed Goose *Anser indicus* is a long distance migrant to the Indian subcontinent, with the major population breeding in China. There is a small breeding population in Ladakh, Mongolia, and Kyrgyzstan. To gain an understanding of their movement pattern and home range, we monitored two PTT tagged Bar-headed Geese (BG111847 & BG111848) captured from the Gharana Conservation Reserve, Jammu & Kashmir, India, during March to August 2012. The origin of the tagged birds, whether from Ladakh or extralimital, could not be ascertained as both the PTTs functioned only for 5–6 months; also, the birds did not move to their breeding grounds till the signals were received in August. During the tracking period, the PTT fitted geese used the Tawi river floodplains of India and Pakistan, in Jammu and Sialkot districts respectively. BG111847 used a 431 km long stretch of the Tawi floodplains, while BG111848 used only a 54 km stretch. The home range of BG111847 was 52.60 sq. km [85% MCP (Minimum Convex Polygon)] and the core area was 7 sq. km (50% MCP), while the home range for BG111848 was 29.68 sq. km (85% MCP) and the core area was 2 sq. km (50% MCP). Post winter, the two geese used around 17 small wetlands in the Tawi river floodplains, moving between India and Pakistan intermittently, indicating the need for cross-border efforts for the long-term conservation of the species in this region. Our results are preliminary and further studies are needed to understand the migration pattern and habitat use of the Bar-headed Goose wintering in the Gharana Conservation Reserve and adjoining areas.

Keywords: Bar-headed Goose, satellite telemetry, migration, home range, wetland, Platform Transmitter Terminal, Important Bird Area

INTRODUCTION

The Bar-headed Goose *Anser indicus* occurs in Afghanistan, Pakistan, Tajikistan, Russia, Bhutan, China, India, Mongolia, Nepal, Bangladesh, Vietnam, Thailand, Uzbekistan, and Kyrgyzstan (IUCN 2014). The major breeding population inhabits China, with smaller populations in Mongolia and Kyrgyzstan (Koppen *et al.* 2010; Takekawa *et al.* 2009). In India, breeding Bar-headed Goose has been reported from Ladakh (Ali and Ripley 1987) where about 500 pairs breed around several lakes and marshes (Hussain and Pandav 2008; Hussain *et al.* 2008; Prins and Wieren 2004). Migrating Bar-headed Geese have been reported from many protected and non-protected wetlands of Assam, Himachal Pradesh, Jammu & Kashmir, Uttar Pradesh, Rajasthan, Andhra Pradesh, Odisha, Karnataka, Tamil Nadu, Kerala, and Maharashtra (Ali and Ripley 1987; Neelakantan *et al.* 1993; Rahmani 1992; Rahmani and Arora 1992; Rahmani and Islam 2008; Rahmani *et al.* 2010).

The Bar-headed Goose is listed as a Schedule I species under the Indian Wildlife (Protection) Act, 1972 and J&K Wildlife (Protection) Act, 1978. Globally, it is a "Least Concern" species (BirdLife International 2002; Collar *et al.* 1994), though it is believed that its population is declining rapidly due to habitat loss, illicit egg collection, and hunting (Koppen *et al.* 2010). Its global population is estimated to be <60,000 (Miyabayashi and Mundkur 1999), with estimates of around 20,000–30,000 wintering in India (Li *et al.* 2009). Over 30,000 birds are reported during winter in China and the Tibet Autonomous Region (Bishop and Drolma 2007; Bishop *et al.* 1997).

Scientists and naturalists have always been fascinated by the Bar-headed Goose due to its ability to fly over the Himalaya during migration to the Indian subcontinent and back (Hawkes *et al.* 2010, 2013; Javed *et al.* 2000; Kalra *et al.* 2011; Lee *et al.* 2008; Swan 1970; Scott and Milsom 2007). Kasambe *et al.* (2008) recovered neck-collared Bar-headed Geese in Maharashtra and Karnataka which were tagged in

Mongolia. Similarly, a neck-collared Goose from Mongolia was reported in Tamil Nadu during winter (Van der Ven *et al.* 2010). The species was found to migrate *c.* 780 km over the Himalaya from India to China (Javed *et al.* 2000). Kalra *et al.* (2011) also recorded their migration between India and China. Platform Transmitter Terminal (PTT) deployed geese in China, Mongolia, and Kyrgyzstan have been reported from Keoladeo National Park (Rajasthan) and Pong Dam (Himachal Pradesh) in India. Bar-headed Geese have been identified as carriers of the highly pathogenic H5N1 virus (Bourouiba *et al.* 2010; Chen *et al.* 2005; Prosser *et al.* 2011; Zhou *et al.* 2006), which necessitates monitoring of their movement pattern at international and regional levels. Hence, we undertook this study to examine the movement pattern and habitat use of the Bar-headed Goose frequenting the Gharana Conservation Reserve using satellite telemetry.

Capture site

The Gharana Conservation Reserve is an 'Important Bird Area' (Islam and Rahmani 2004), situated near Gharana village in Ranbirsinghpora *tehsil* in the Tawi floodplains (32° 32′ 26″ N; 74° 41′ 24″ E) of Jammu & Kashmir State. It is *c.* 500 m from the India-Pakistan international border and is a small wetland with an area of *c.* 100 ha surrounded by agricultural lands. The wetland is covered with Water Hyacinth *Eichhornia crassipes* and *Typha* sp. (Islam and Rahmani 2004). The Tawi river, agricultural lands, and several small wetlands adjacent to Gharana offer habitats for waterbirds in the floodplains. A study reported 21 species of waterbirds from this wetland (Sharma and Saini 2012) with around 20,000 birds reported during winter, which includes more than 2,000 Bar-headed Geese (Islam and Rahmani 2004). The adjacent floodplains of Indus, Degh, Panynad, and Ravi rivers in Pakistan also have wintering population of Bar-headed Geese numbering around 5,000 (Koppen *et al.* 2010; Van der Ven *et al.* 2010). The nearest breeding ground for the Bar-headed Goose from Gharana is Ladakh, *c.* 300 km to its north. The breeding sites in Ladakh mainly comprise lacustrine (e.g., Tso Kar, Tso Morriri) and palustrine (e.g., Dungti, Chushul) wetlands (Chandan *et al.* 2005; Islam and Rahmani 2004; Prins and Weiren 2004). In China, their breeding sites are steppes, saline meadows, swamp meadows, alpine meadows, and cropland habitats, while preferred stopover sites are lakes, marshes, and shallow wetlands (Zhang *et al.* 2011).

METHODS

Capture and deployment of PTTs

On March 19, 2012, seven adult Bar-headed Geese were captured from the Gharana Conservation Reserve using noose snares by trained professional bird trappers of the Bombay Natural History Society. After biometric measurements, two individuals were randomly selected for the deployment of pre-designed PTTs. The PTT model TAV-2630, with around nine months of battery life, was attached onto the backs of the birds with a backpack harness. The weight of PTT was 29 gm, which is around 1% of the total body weight of the geese and is within the recommended 3% weight limit (Wilson and McMahon 2006). Unique identification numbers were given to the birds, *viz.* BG111847 and BG111848, for receiving data from ARGOS (ARGOS 2007). PTTs were set to receive five fixes per 24 hour cycle. Generally, ARGOS provides fix (location) classes of different accuracies; the high accuracy fix classes are 3, 2, 1 and 0. Low accuracy classes A, B, and Z are also transmitted from the PTT. The high accuracy fix classes provide a range of error as follows: 3 = <150 m, 2 = 150–350 m, 1 = 350–1,000 m and 0 = >1,000 m. As classes A, B, and Z indicate poor satellite connection (ARGOS 2007), only classes 3 to 0 were used for analysis (Ueta 2000).

Data analysis

We used adehabitatHR for home-range and movement pattern analysis in R core 3.0.2 version software (R Development Core Team 2014). Conventional Minimum Convex Polygon (MCP) method was used for home range analysis and core area was calculated with 50% MCP. ARGOS fixes received from both individuals were overlaid on Land Use Land Cover (LULC) maps using ArcGIS Version 9.3 (ESRI 2008). Habitat types were broadly divided into five categories, namely water (river and waterbodies), vegetation (largely grass-dominated areas), settlement (village and town), agriculture, and open areas (uncultivated and riverbed). We used Google Earth images Version 6.1 (Google, Mountain View, California, USA) to identify wetlands utilized by the geese and the potential wetlands in the region suitable for geese and other waterbirds.

RESULTS

Performance of PTTs

We received 647 fixes between March and August 2012, with maximum fixes during April, and minimum during August 2012 (Fig. 1). We analyzed 205 high class fixes [from both geese, Location Class (LC) 3 (33%), followed by LC 2 (32%), LC 1 (26%) and LC 0 (9%)], of which 176 fixes were of BG111847 and 29 were of BG111848. The PTT on BG111847 functioned till August 2012 while that on BG111848 provided irregular fixes till July 2012 (Table 1). Both the PTTs functioned for 5–6 months below the expected life of 9 months.

Table 1: Home range (50% & 85% MCP) and movement pattern of two PTT-fitted Bar-headed Geese captured in Gharana Conservation Reserve

Bird ID	Start Date	Total Fixes	Fixes used for analysis	End Date	50% MCP (sq. km)	85% MCP (sq. km)	Movement (km/day)
BG111847	March 19, 2012	550	176	August 25, 2012	7	52.60	2.69
BG111848	March 19, 2012	97	29	July 7, 2012	2	29.68	0.46

Spatial Distribution

We computed 85% MCP after excluding the outliers. As depicted in Fig. 2, 90% MCP for BG111847 was justifiable, unlike BG111848. As prominent increase in home range of BG111848 till 90% was ineffective, we determined home range using an acceptable average of 85% MCP, and core range was computed with 50% MCP. Average home range of the two birds was calculated as 41 sq. km (85% MCP), and core area as 4 sq. km (50% MCP).

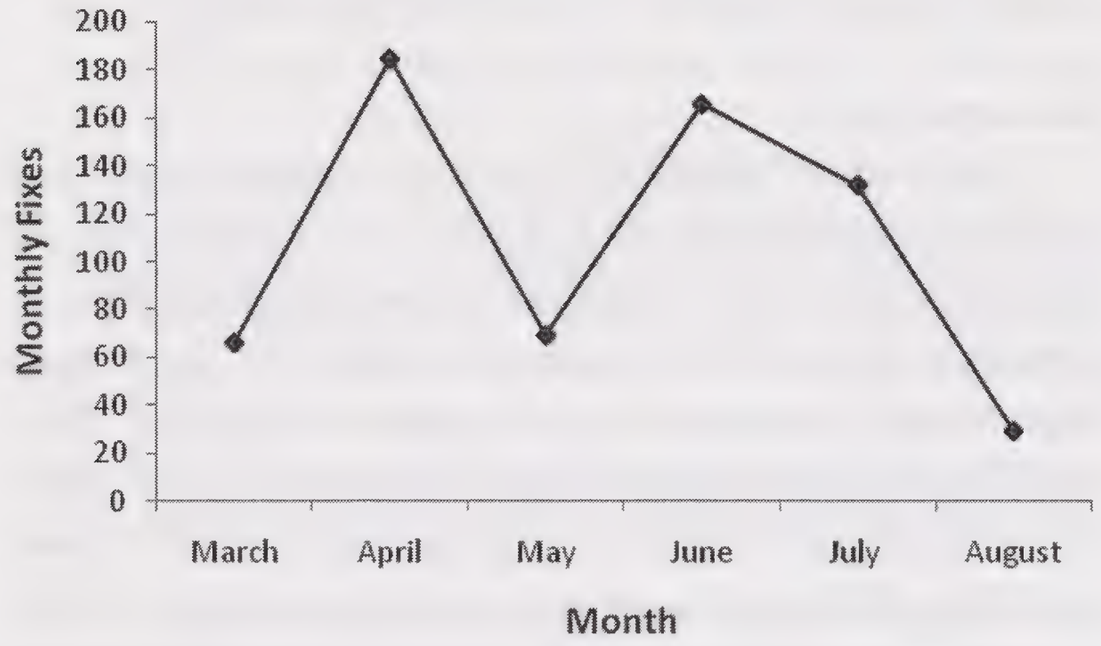

Fig. 1: Monthly fixes received from ARGOS for two PTT-fitted geese captured in Gharana Conservation Reserve

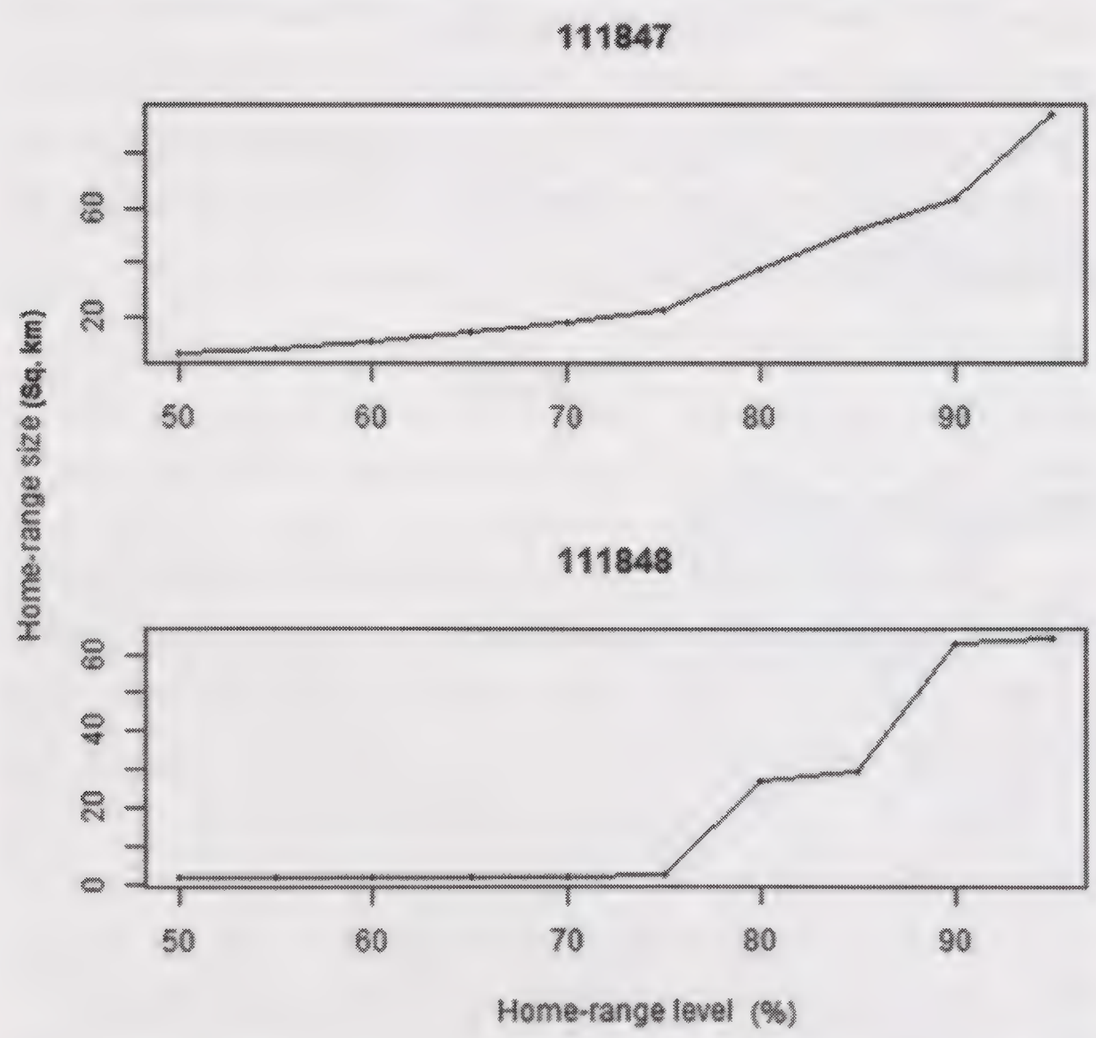

Fig. 2: Saturation in home ranges of two PTT-fitted Bar-headed Geese captured in Gharana Conservation Reserve

Individually, the home range of BG111847 was 52.60 sq. km with a core area of 7 sq. km that mainly consisted of wetlands/waterbodies. The core area for BG111847 was in Chaprar, Pakistan, and near Ranbirsinghpora, India. The home range of BG111848 was 29.68 sq. km between March to July (Fig. 3), with a core area of 2 sq. km in and around Tawi river within Indian territory, *c*. 12 km away from Gharana (Fig. 4). Both the individuals did not return to Gharana after tagging; they moved towards the north and used the Tawi floodplains extensively. There was an overlap of 10 sq. km area between the home ranges of these two birds, but no interaction was recorded since very few fixes were received from the overlapping area (Fig. 3).

Movement Pattern

Instead of migrating towards Ladakh/Central Asia/ China, the geese that were tagged in March 2012 remained in Tawi floodplains till July–August 2012. The birds moved extensively within areas of the Tawi floodplains in Jammu (India) and Sialkot (Pakistan). For BG111847, the total movement was computed as *c*. 431 km and the average movement was 2.69 km/day (Table 1), while the maximum distance between two consecutive fixes was 25 km. The PTT-fitted goose occasionally visited nearby areas of River Chenab in Pakistan (Fig. 5). Eventually, BG111847 settled in Chaprar (Pakistan) till we received the last fix in August 2012. BG111848 moved *c*. 54 km, and the average distance travelled was 0.46 km/day with a maximum of 13 km between two consecutive fixes on March 21, 2012; the last fix for this bird was received in July 2012.

Habitat Use

Most of the fixes were received from open areas (a combination of open barren lands, empty crop lands and riverbeds), followed by vegetation (mostly grass-dominated areas), agriculture and wetlands (Fig. 6). Fixes were not received from any human settlements, indicating that the geese avoided such areas. The least number of fixes were received in water/wetland habitats, most of the fix clusters in other habitat types were within 1–2 km of the Euclidean flight distance from the wetlands. The total area used by the two

TRACKING MOVEMENT PATTERN OF BAR-HEADED GOOSE CAPTURED FROM GHARANA CONSERVATION RESERVE

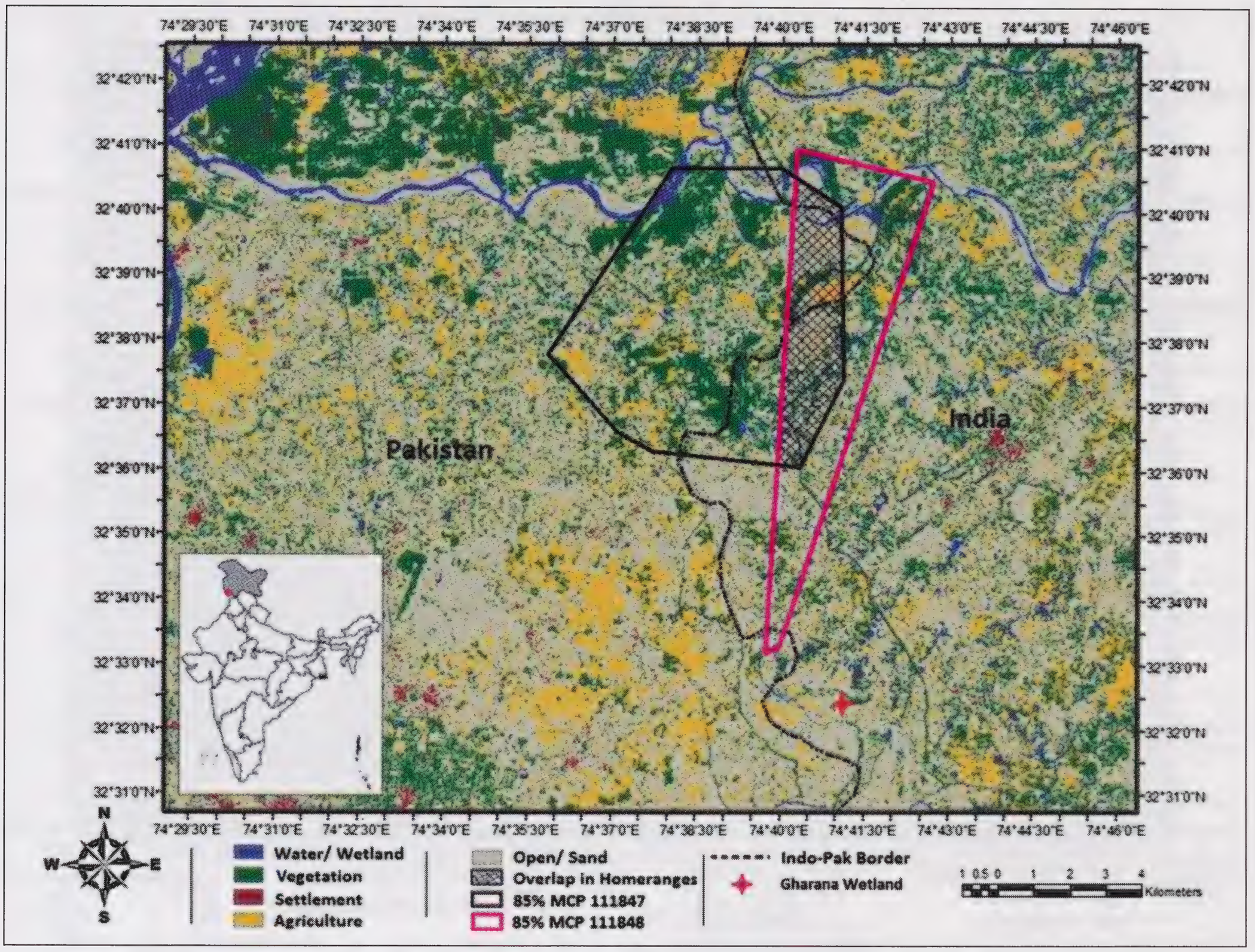

Fig. 3: Home ranges (85% MCP) of two PTT-fitted Bar-headed Geese captured in Gharana Conservation Reserve

Table 2: Wetlands in Tawi floodplain of India and Pakistan

Wetland ID (see Fig. 7)	Area (sq. km)	Perimeter (km)	Type	Country
1	0.005	0.15	Canal	P
2	0.004	0.292	Pond	I
3	0.006	0.418	Pond	P
4	0.001	0.146	Pond	P
5	0.431	4.5	Pond, Canal	I & P
6	0.001	0.19	Pond	P
7	0.014	0.057	Pond	P
8	0.002	0.21	Pond	P
9	0.002	0.246	Pond	P
10	0.019	0.781	Pond	P
11	0.014	0.712	Pond	P
12	0.023	0.7	Pond	P
13	0.0008	0.126	Pond	P
14	0.125	5.6	Stream	P
15	0.014	0.797	Canal	I
16	0.004	0.666	Pond	P
17	0.0006	0.13	Pond	P

Source: - Google Earh Image; I - India and P – Pakistan

birds was *c*. 72 sq. km, of which open area constituted 31.78 sq. km, followed by areas with grass-dominated vegetation (25.58 sq. km), agriculture (10.41 sq. km), and river/wetland (3.21 sq. km). The home range, however, encompassed 0.47 sq. km human settlements.

Important wetlands in the Tawi floodplain

The birds used around 17 small wetlands in the Tawi floodplain (Fig. 7; Table 2), varying in size from *c*. 0.0006 to 0.431 sq. km with a total available area of *c*. 0.66 sq. km, of which *c*. 0.44 sq. km was in India and *c*. 0.22 sq. km in Pakistan. Most of these wetlands served as optional habitats for the geese. Occasionally, stagnant water canals were used. In Chaprar (Pakistan), *c*. 0.20 sq. km cluster of wetlands were utilized by BG111847 in July and August. Among these clusters, smaller wetlands of size 0.0008 sq. km also served as staging sites (Table 2). Apparently, these are potential habitats for waterbirds in the Tawi and Chenab river floodplains in India and Pakistan (Fig. 7).

DISCUSSION

Neck-banded Bar-headed Geese have been reported

TRACKING MOVEMENT PATTERN OF BAR-HEADED GOOSE CAPTURED FROM GHARANA CONSERVATION RESERVE

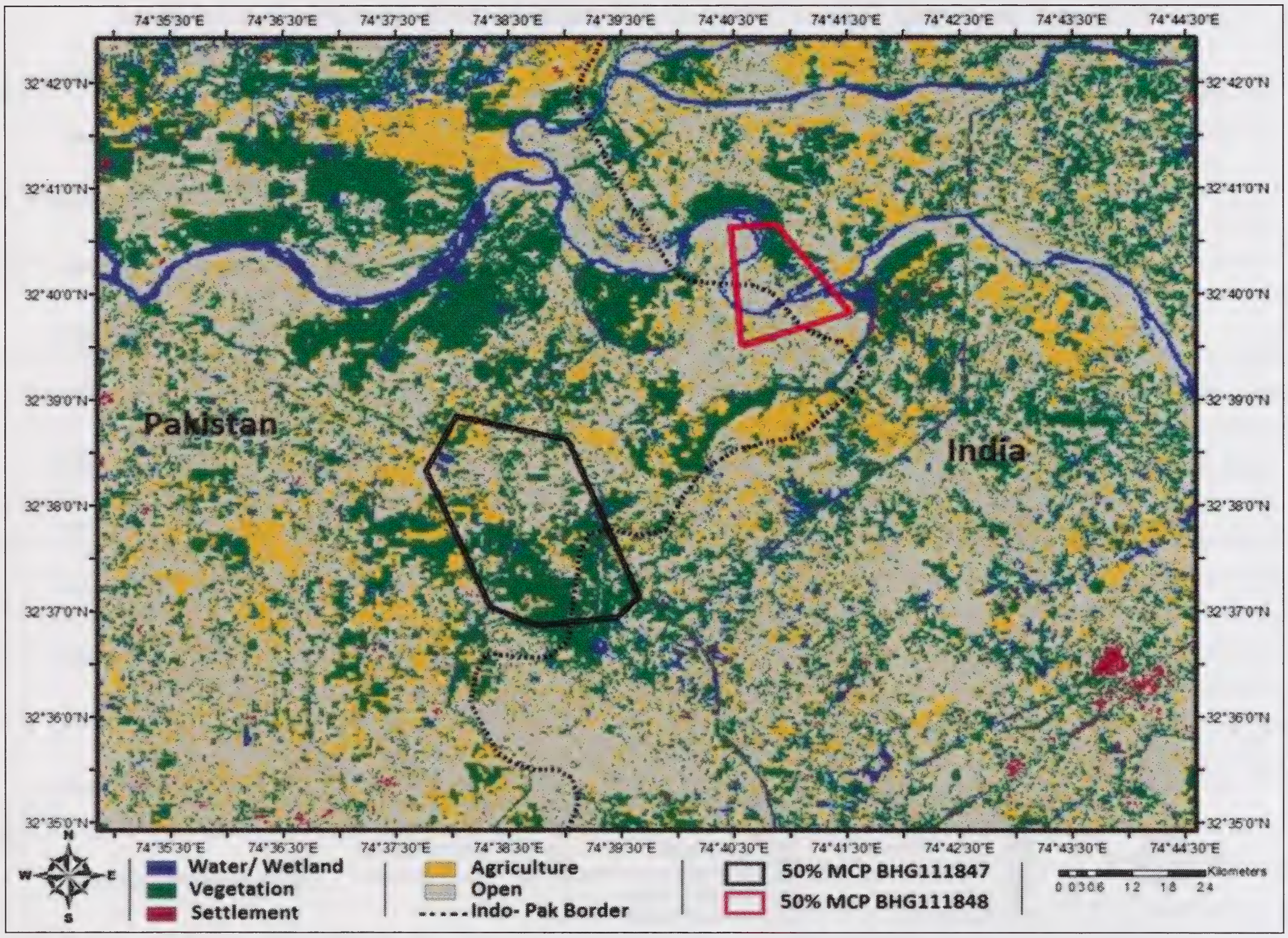

Fig. 4: Core areas (50% MCP) of two PTT-fitted Bar-headed Geese captured in Gharana Conservation Reserve

to visit the Gharana Conservation Reserve (Agency India Press, December 23, 2011; DNA December 27, 2011), which are believed to have been tagged in Mongolia, the Qinghai province of China, or possibly Himachal Pradesh (A.R. Rahmani, pers. comm.). Earlier satellite tracking studies reported the maximum migration distance of the Bar-headed Goose to be 3,000 km, from Mongolia to India (Hawkes *et al.* 2013; Takekawa *et al.* 2009). PTT-fitted Bar-headed Geese from Keoladeo National Park (Rajasthan) and Sur Sarovar (Uttar Pradesh) moved to their breeding grounds in the Tibetan Autonomous Region and Xizang Province (China) by March–April (Javed *et al.* 2000; Kalra *et al.* 2011). However, our study showed a comparatively short movement (maximum 431 km) and the birds were recorded in the Tawi floodplains of India and Pakistan till August (Table 3). This indicates that either the PTT-fitted birds are from a resident population of nearby areas, such as Ladakh, or they did not return to their breeding sites because of some other reason, which needs further investigation.

The extent of area utilized by the two PTT-fitted birds in our study varied perhaps due to the availability of suitable habitats or inter/intra-specific competition among species (Schoener 1968; Nudds and Ankney 1982). However, from the small sample size, we could not make any definitive conclusion in the difference observed in the extent of area used by these two birds. Gharana is a very small wetland, so, agricultural land around it and other smaller wetlands serve as an obligate habitat for wintering waterbirds such as Bar-headed Geese. The PTT-fitted birds did not return to Gharana, but used nearby wetlands and agriculture fields and

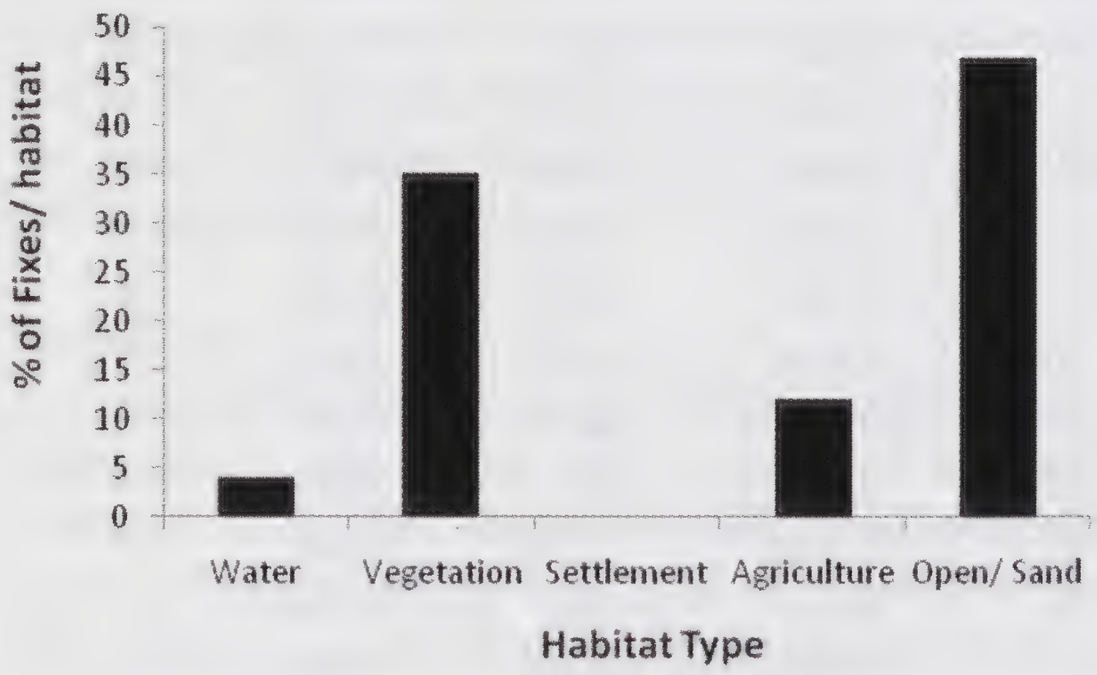

Fig. 6: Percentage of ARGOS fixes of two PTT-fitted Bar-headed Geese captured in Gharana Conservation Reserve in different habitats

Note: Vegetation here denotes grass-dominated areas

TRACKING MOVEMENT PATTERN OF BAR-HEADED GOOSE CAPTURED FROM GHARANA CONSERVATION RESERVE

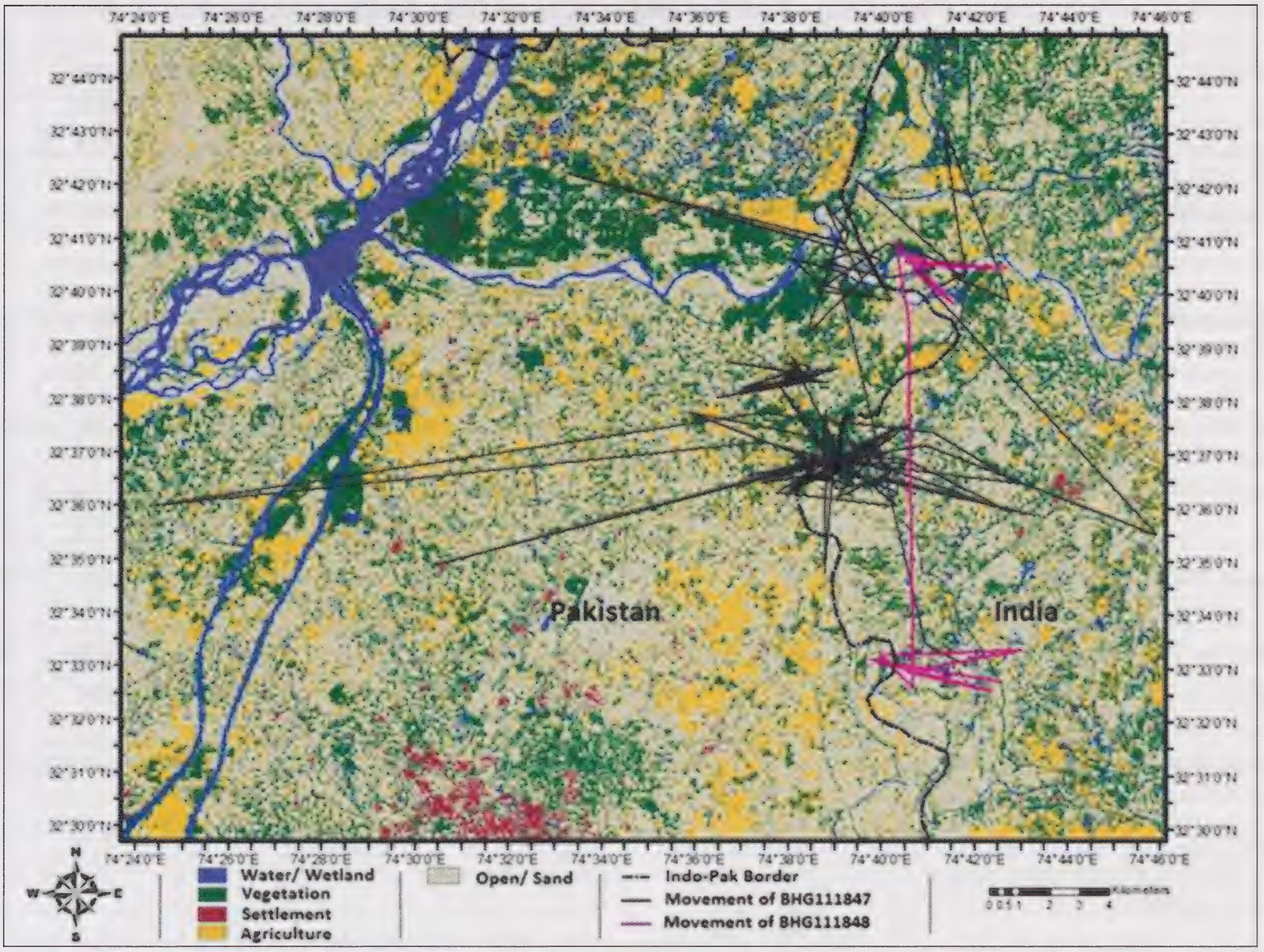

Fig. 5: Movement pattern of two PTT-fitted Bar-headed Geese captured in Gharana Conservation Reserve

Fig. 7: Important wetlands outside Gharana Conservation Reserve, India
Source: Google Earth accessed 12 September 2014

Table 3: Migration and movement pattern of satellite-tracked Bar-headed Geese

Reference	Type of Transmitter	Total distance covered (km)	Individuals tagged	Countries recorded	Type of migration	Stopover sites	Total days of movement	Total Fixes
Javed *et al.* 2000	PTT	~780	2	India, China	Spring	3	137	192
Takekawa *et al.* 2009	PTT	500–3,000	60	China, India, Mongolia, Nepal	Winter, Fall, Spring, Breeding, Moult	NA	1-213	93,009
Koppen *et al.* 2010	PTT	790–1,550	4	Uzbekistán, Kyrgyzstan, Tajikistán, India, Pakistán	Autumn and Spring	4	1–53	5000
Guo-Gang *et al.* 2011	PTT	1,270–1,470	10	China	Autumn	4	50–90	NA
Cui *et al.* 2011	PTT	17.89–404.41	21	China	Moult, Autumn and Breeding	NA	185–298	16,342
Prosser *et al.* 2011	PTT	260–2,330	15	China, India	Breeding and Spring	7	1–154	NA
Kalra *et al.* 2011	PTT	807–1,305	4	China, India	Winter	2	193–263	4663
Zhang *et al.* 2011	PTT	1,300–1,500	11	China	Autumn	5	73–83	NA
Hawkes *et al.* 2013	PTT	3,000	91	India, China	Autumn and Spring	NA	135–1,216	NA
This Study	PTT	54–431	2	India, Pakistan	Winter	NA	115–160	647

*NA= Not Available

grasslands in India and Pakistan, indicating that this landscape as a whole is important for migratory birds.

In the last few decades, hunting and anthropogenic pressures have adversely affected the population of the Bar-headed Goose in Kyrgyzstan (Koppen *et al.* 2010). Even if these birds do not migrate to other countries, there still exists a potential threat of avian influenza via interaction with migratory populations of other species. Hotspots of interaction must be located and prioritized for national and trans-boundary conservation efforts, since there might be possibilities of uncertain conservation status in other countries. For instance, in India, population loss of Siberian Crane was attributed to population decline during migration (Meine and Archibald 1996). Thus, the conservation of migratory Bar-headed Goose populations would be uncertain without trans-boundary collaborations. Additionally, studies with a landscape approach are needed for the identification and conservation of multiple stopover sites, since waterbirds migrate long distances within different geographic regions and countries seasonally.

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REVIEW

NATURE AND NATION: ESSAYS ON ENVIRONMENTAL HISTORY by Mahesh Rangarajan. 2015. Published by Permanent Black in association with Ashoka University, Ranikhet. Size: 21 cm x 13.5 cm. Price: Rs. 795/-. Hardbound.

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Mahesh Rangarajan, former Director of Nehru Memorial Museum and Library, New Delhi, and Professor of History, Delhi University, is perhaps India's finest environmental historian, with a deep interest in wildlife conservation and human rights. His essays are a treat to read and his lectures are a delight to hear. He has written many seminal books, such as INDIA'S WILDLIFE HISTORY: AN INTRODUCTION (2000), THE OXFORD ANTHOLOGY OF INDIAN WILDLIFE (in two volumes, edited, 2001–02), INDIA'S ENVIRONMENTAL HISTORY: A READER (co-edited, 2012). His books, essays in journals and magazines such as *Economic and Political Weekly*, and lectures have helped to formulate new thinking in wildlife conservation where human beings and human welfare, particularly of the marginalized communities, is an integral part of wildlife and environmental conservation.

His present book is a joy to read, with 10 longish chapters/essays on varied subjects ranging from 'Of Nature and Nationalism: Rethinking India's Nehru' to 'Parks, Politics, and History: Conservation Dilemmas in Africa'. Each chapter is lucidly written and profusely referenced – a clear indication of his erudition. For quick reference and notes, a citation is given at the bottom of the page, with full bibliographic references given at the end of each chapter. This helps in going to the original reference and learning more on the subject.

Although all the chapters are enjoyable, I liked Chapter 3: 'From Princely Symbol to Conservation Icon'. This is about the political history of the Asiatic Lion in India. Unfortunately, this majestic beast is still a political 'animal'. The Gujarat government is still refusing to give a pride of Asiatic Lions, mistakenly called Gir Lion, to the Madhya Pradesh government for reintroduction in Kuno-Palpur Wildlife Sanctuary that was meticulously and scientifically developed to receive them after they became locally extinct more than a 100 years ago. Besides some inane reasons of temperature differences in Gir and Kuno-Palpur, some say that the introduced lions will become man-eaters. Mahesh has rightly pointed out "no single region in India had a history of man-eating lions in quite the way in which the Sundarbans of the Bengal delta were known for harbouring dangerous tigers. The lion was the scourge of domestic animals rather than people." With the arrival of the British and rifles, rapid decline of Asiatic Lion took place due to the relatively open countryside in which it lived. For example, George Acland Smith, a British officer, shot 50 lions in the Delhi region in 1857–58. His total tally was 300 lions. With such a massacre of the noble beast, no wonder it became extinct in the greater part of its range, with only a few surviving in the Gir forests by the early 1900s. How the Nawab of Junagadh revived the population is too well-known to be commented upon here.

Another wonderful chapter is 'Of Nature and Nationalism: Rethinking India's Nehru'. The learned author has shown how Pandit Jawaharlal Nehru, the first Prime Minister of India and the architect of modern India was essentially a lover of nature, fascinated by mountains, rivers, forests, animals, and trees. Nehru was a devotee of modernity, science, and technology. His famous words "Large dams are the temples of modern India" is now derided by many people who oppose large dams, but Nehru's statement was contextual. The newly emerged nation, after the horrific killings of Partition and struggling to contain its poverty, needed a symbol to look up to. For Nehru, Bhakra Nangal Dam was the symbol indicating his vision of industrialized and modernized India. This chapter succinctly describes Nehru's vision of India. In his vision, Nature was not neglected. For example, when he came to know that the Asiatic Lion was again in danger of extinction due to anarchy after the Nawab of Junagadh fled to Pakistan, he implored the officials to protect these animals. He wrote "It would be a great pity if they were allowed to be shot or otherwise to suffer extinction." How I wish such quick conservation actions could be taken for a plethora of species that are now on the verge of extinction.

The third chapter that I liked most is 'The Politics of Ecology: The Debate on Wildlife and People in India 1970–1995'. These were the formative years of Mahesh Rangarajan when he was developing his thoughts as a young man, a member of a newly established Bird Club in Delhi, voracious reader of the wonderful nature articles by M. Krishnan in *The Statesman*. These were the years (1970s to early 1980s) when under Indira Gandhi, the Indian Board for Wildlife (now called National Board for Wildlife) would meet almost twice a year. These were the years when the Wildlife (Protection) Act and the Forest (Conservation)

Act were established, which are even now helping the natural security of India. This was the time when large numbers of protected areas were established. This was also the time when the foundation for the Environment (Protection) Act was laid. All this is very well brought out in this chapter.

Overall the book is wonderful and informative, never too heavy to read. I would recommend it highly to young researchers, wildlifers, conservationists, human right activists, and most importantly to decision makers.

■ ASAD R. RAHMANI

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MISCELLANEOUS NOTES

1. A NOTE ON SEED DISPERSAL OF ROCK BANANA *ENSETE SUPERBUM* BY ASIAN PALM CIVET *PARADOXURUS HERMAPHRODITUS* AT SINHGAD FORT, MAHARASHTRA, INDIA

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Ensete superbum (Roxb.) Cheesm., commonly known as Rock Banana, is a close relative of banana *Musa* sp. It is endemic to the Western Ghats, and grows in rocky crevices and steep slopes. It appears after the first monsoon shower and attains full growth by post-monsoon (October–November). Most of the Rock Banana flower in monsoon and fruiting takes place in the dry season; mature fruits can be observed from February till end of May. As summer approaches, the plant starts dying and only dried stumps remain by March–May. As this species is non-stoloniferous, it propagates through seeds and needs an effective seed disperser for regeneration (Gokhale *et al*. 2010). However, the plant may appear to be stoloniferous when its seeds grow in closed clumps. Though commonly seen in the Western Ghats, Rock Banana population is declining fast due to various biotic and abiotic pressures (Gokhale *et al*. 2010).

Punekar (2002) reported *Ensete superbum* as a food plant of Hanuman Langur *Semnopithecus dussumieri*, whereas Mudappa *et al*. (2010) observed seeds of *E. superbum* in the faecal matter of Brown Palm Civet *Paradoxurus jerdoni*. Gokhale *et al*. (2010) reported several species of birds visiting this plant for its fruits, as well as insectivorous birds such as Brown-capped Pygmy Woodpecker *Picoides nanus*, Franklin's Prinia *Prinia hodgsonii*, Black-headed Cuckoo-shrike *Coracina melanoptera*, and Common Tailorbird *Orthotomus sutorius*. It is very likely that these birds are attracted by the nectar or by insects associated with flowers, and may not have a role in seed dispersal. We conducted this study because there is no substantial information on seed dispersal of *E. superbum* by other frugivorous animals, post-dispersal germination percentage, or fate of dispersed seeds.

The study site Sinhgad fort (18° 21′ 56″ N; 73 ° 45′ 26″ E), Pune, Maharashtra, is situated in Bhuleshwar hill range – spreading east-west to the main ranges of northern Western Ghats. The entire *c*. 23 ha area of the fort is a small basaltic highland at an elevation of 1,280 m above msl. The terrain is steep and rugged. The steep slopes and mountain top are covered with basaltic bedrock or a shallow, loose layer of soil which bears mainly herbaceous plants. Forest patches can be seen at the base of the hills, on gentle slopes, and around gullies and nullahs. *E. superbum* is predominantly found on such slopes. Based on the level of anthropogenic disturbance and vegetation composition, the study area was broadly categorized as: a) human habitation occupying *c*. 30% of the total area of Sinhgad and b) grassland surrounding human habitation occupying *c*. 70% of the total area. Human habitation included houses, lodges, telecommunication offices, and ancient structures such as cisterns and ruined temples. Vegetation in human habitation was mainly introduced and exotic species, whereas vegetation observed in grassland was similar to that of the rocky highlands of the northern Western Ghats, dominated by herbs with scattered shrubs and stunted trees. Vegetation on these rocky highlands, especially herbs, shows remarkable seasonality, i.e., luxuriant growth of herbs in monsoon followed by almost barren highlands, with patches of grasses and a few perennial herbs.

We conducted field survey fortnightly during the dry season (January–May) in 2012 and 2013. Due to heavy rainfall and prolific growth of grasses, we were unable to collect data during the monsoon and post-monsoon periods. In summer season, there was scarcity of fruits, and we observed that *Ensete superbum* and *Ficus racemosa* were the only profusely fruiting plants on the fort and surrounding areas. Asian Palm Civet *Paradoxurus hermaphroditus* in Sinhgad mostly rested in rocky crevices and thick vegetation in gullies during the day, appeared after dusk and started climbing steep slopes to reach the fort in search of food, especially *E. superbum*, *F. racemosa* in and around garbage dumps. Sighting of 3–5 civets feeding on the garbage dumps near

human habitation was not uncommon at Sinhgad. We walked around the fortified edges of the fort and searched for the civets. Eight independent surveys were conducted to study the relative abundance of the civets at Sinhgad. The total distance walked was 20 km (2.5 km/survey) and the average number of civets recorded was 3.8 (range 1–6). Pooled encounter rate was 0.19 civets /km.

We found that Asian Palm Civet *P. hermaphroditus* was the major seed disperser of *E. superbum*, hence we concentrated our efforts on this species. We collected a total of 171 faecal samples of the civet during this investigation. The total number of seeds counted was 13,698 with an average of 80.11 ±4.64 seeds/scat (range 31–157). In 2012, we found 127 faecal samples while in 2013 they were reduced to 44. Seeds collected from scats and control samples were induced for germination. A total of 100 seeds were germinated in plastic trays using the same field soil during the following monsoon. We found that seeds from civet faeces showed 1% germination, whereas in the control germination rate was 6%. In other studies (Mudappa *et al.* 2010), germination percentage of the excreted seeds is always greater than control seeds because of endozoochory, but in our study the rates of germination were unexpectedly lower and could not be explained. Further investigation is needed to understand this pattern of seed germination.

In the northern Western Ghats, most of the rocky plateaux face several threats (except those in protected areas), and immediate conservation action is needed to protect them (Watve 2013). Sinhgad fort has immense pressure from tourism activities, which affect the habitat found on this basaltic plateau (Watve 2013). Besides tourism, due to its easy accessibility Sinhgad also faces other anthropogenic pressures such as uncontrolled grazing and post-monsoon fires. In 2013, due to human-induced fires, we found a very small number of civet faecal samples, which may have been due to burning of most of its habitat on the fort. Alternatively, the civets may have temporarily changed to other diet. This change in the civet's diet may affect dispersal of *E. superbum* and could also lead to human-wildlife conflict. The current study showed that *E. superbum* was a major food component of Asian Palm Civet's diet during dry season. We recommend further detailed investigation to provide more data to understand rocky outcrop habitats and human-modified ecosystem at Sinhgad.

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2. PREDATION ON BLACKBUCK *ANTILOPE CERVICAPRA* FAWN BY WILD BOAR *SUS SCROFA* IN POINT CALIMERE WILDLIFE SANCTUARY, TAMIL NADU, INDIA

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Wild Boars are generalist feeders and are considered as opportunistic omnivores (Rosell *et al.* 2001; Schley and Roper 2003). The ability to adapt to diverse food habits has helped them to establish their populations in a wide range of habitats and hence they have a large geographical range (Baubet *et al.* 2004). Wild Boars are variously reported to be frugivores, crop pests, seed bank destroyers, predators and plant dispersers (Bueno *et al.* 2011; Geisser and Reyer 2004; Genov 1981; O'Connor and Kelly 2012). Studies in Europe have shown that wild boars scavenge on carrion and predate on ground nesting birds and amphibians (Carretero and Rosell 1999; Giménez-Anaya *et al.* 2008; Herrero *et al.* 2005). However, detailed analysis of the food habits of wild boars showed foraging preference of plant matter over animal matter (Ballari and Barrios-García 2014).

We report an incident of Wild Boar (adult male) preying on Blackbuck *Antilope cervicapra* fawn at around 10:30 hrs on January 21, 2013, in Point Calimere Wildlife Sanctuary,

Fig.1: Wild Boar preying on the Blackbuck fawn

southern India. The Sanctuary has patches of stagnant water in the low-lying areas due to rain received from the North-east monsoon. The Wild Boar was seen chasing a Blackbuck fawn and knocking it down in the grassland habitat (Fig. 1). The mother of the fawn gave an alarm call and tried to help, but her efforts were in vain. The fawn attempted to escape from the Wild Boar but could not once it entered the water. The Wild Boar chased the fawn in the water and bit into its back. The severely injured fawn managed to escape, but died because of excessive bleeding. The Wild Boar left the place leaving the dead fawn behind as its mother was nearby and repeatedly giving alarm calls.The fawn was around 3–5 days old. This entire incident happened in three minutes. We observed wild boars chasing blackbuck fawns during January to April 2013, on three occasions, in the study area. Though there were reports of blackbuck fawns being preyed upon by jackals *Canis aureus* and stray dogs in Point Calimere Wildlife Sanctuary by the locals, this is the first report of predation by Wild Boar.

Wild Boar is one of the most widely distributed mammals in the world (Massei and Genov 2004) and a few studies have documented predation of wildlife species by wild boar (Loggins *et al*. 2001; Oliver and Brisbin 1993) hunting and consuming young lambs in Australia (Pavlov and Hone 1982). In India, there are reports of predation by Wild Boars on Bonnet Macaque *Macaca radiata* in Bandipur National Park (Shreejata 2014) and on Chital *Axis axis* in Bandhavgarh National Park (Behera and Gupta 2007). There are also reports of wild boars carrying newborn Chital fawns in Sariska Tiger Reserve (Sankar pers. obs.). However, reports of active predation on other vertebrates by Wild Boar are limited.

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3. INDIAN BLACK IBIS *PSEUDIBIS PAPILLOSA* FEEDING ON CARRION

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The Indian Black Ibis *Pseudibis papillosa* is endemic to the Indian subcontinent and occurs in various habitats from desert to wetlands from south-east Sind, eastwards to Bangladesh and southwards, especially along the eastern Peninsula (Manakadan *et al*. 2011). It is reported to feed on a varied diet, ranging from frogs, small fish, earthworms, lizards, small snakes, scorpions, crustaceans, grain beetles, and other insects (Ali and Ripley 1987).

During a BNHS camp at Rajasthan, two birds were spotted at the Jor Beed carcass dump near Bikaner (27° 57′ 57″ N; 73° 22′ 43″ E). They seemed to be pecking at carcasses, and were spending a considerable amount of time at each spot. On observing with a spotting scope, it was seen that the birds were not feeding on the maggots, as presumed, but were tearing small pieces of flesh from the carcass, and feeding on it. The birds spent around 10–15 minutes on each carcass before moving on to the next. This is possibly the first record of the species feeding on carrion.

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4. NEW RECORD OF FERRUGINOUS POCHARD *AYTHYA NYROCA* (GÜLDENSTÄDT, 1770) FROM ANDAMAN & NICOBAR ISLANDS, INDIA

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The Andaman & Nicobar archipelago comprises 572 islands, islets, and rocky outcrops extending over 800 km and running north to south between 6° 45′–13°30′ N and 90° 20′–93° 56′ E with an area of 8,249 sq. km. The Andaman & Nicobar Islands can be broadly divided into two groups, namely the Andamans and the Nicobars. These two groups are separated by the ten-degree channel, which is about 150 km wide and 400 fathoms deep. Average annual temperature varies from 24° to 28° C and the rainfall is slightly higher in Nicobar, with an annual average of 3,000 to 3,500 mm. The elevations range from sea level to 732 m at Saddle Peak in North Andaman and 642 m at Mount Thulier in Great Nicobar Island, Nicobar group. The study on avifauna of Andaman & Nicobar Islands were initiated by Beavan (1867) listing the avifauna of Andaman Islands, followed by Hume (1873, 1874a,b, 1876), and Abdulali (1964, 1965, 1967, 1971, 1978, 1981). Recently, a few researchers contributed to the avifauna of Andaman & Nicobar Islands (Chandra and Kumar 1994; Chandra and Rajan 1994; Ezhilarasi and Vijayan 2006; Pande *et al*. 2007; Sankaran 1995, 1998, 2001; Sankaran and Vijayan 1993; Sivakumar 2007; Sivakumar and Sankaran 2002; Sivaperuman *et al*. 2010, 2012, 2013, 2014; Tikader 1984; Vijayan 1996, 2007; Yahya and Zarri 2003; Yoganand and Davidar 2000).

As a part of major ecological studies on wetland birds in south Andaman initiated during 2012, supported by the Science Engineering Research Board (SERB), Ministry of Science & Technology, and INS Utkrosh, Ministry of Defence, Government of India, we have been surveying the tsunami inundated wetlands of South Andaman to assess wetland bird communities. During these surveys a pair of Ferruginous Duck *Aythya nyroca* (Güldenstädt) was recorded at Sippighat, South Andaman (11° 36.230′ N; 92° 41.435′ E) on December 17, 2014, along with a flock of Lesser Whistling Teal *Dendrocygna*

javanica, Purple Moorhen *Porphyrio porphyrio*, Cotton Teal *Nettapus coromandelianus*, and Common Moorhen *Gallinula chloropus*. The Ferruginous Duck was sighted again on December 19 and 21, 2014, in the same location. The tsunami inundated wetlands in South Andaman have attracted larger numbers of waterbirds during these years; as a result the authors recently reported many new sightings of migratory birds from this region (Sivaperuman *et al*. 2012, 2013, 2014).

The Ferruginous Duck sighted were adult male and female. The head, neck and breast of male was deep chestnut while female had dull reddish head, neck and breast. According to Ali and Ripley (1983) and Arun Kumar *et al*. (2005), this species is common in North India, Pakistan, Nepal, Bhutan, Bangladesh, Sri Lanka, and Maldives. It breeds in Central Asia to Western China and Western Mongolia, Kashmir Valley and Ladakh in India, central and eastern Europe, and north Africa (Arun Kumar *et al*. 2005; Vinicombe 2000). The Ferruginous Duck is listed as Near Threatened (NT) in the IUCN Red List (BirdLife International 2012) and also listed in the Appendices I and II of the Convention on Migratory Species (CMS or Bonn Convention). Review of literature revealed that this species has not been reported from Andaman & Nicobar Islands and this is the first report of Ferruginous Duck from the Islands.

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5. RECORD OF COMMON TERN *STERNA HIRUNDO* FROM ANDAMAN & NICOBAR ISLANDS, INDIA

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The Common Tern *Sterna hirundo* has a large global range, breeding in most of Europe, parts of Asia and North America; wintering south to South America, Africa, parts of Asia and Australia (BirdLife International 2015). In the Indian subcontinent, it breeds in Ladakh (Pangong Tso, Tso Kar, and Tso Moriri), Adam's Bridge between Sri Lanka and India, and Sri Lanka, and winters in most parts of the mainland subcontinent in large rivers, lakes, and the coasts. Offshore, it has been reported from the Maldives, but not from the Andaman & Nicobar Islands (Abdulali 1967; Ali and Ripley 1987; Kazmierczak 2008; Manakadan *et al.* 2011; Pande and Anvita 2011; Pande *et al.* 2007; Rasmussen and Anderton 2005)

On January 17, 2015, during a BNHS camp to Andaman, a tern in non-breeding plumage was observed at Corbyn's Cove Beach (11° 38′ 42″ N; 92° 44′ 56″ E), which appeared to be a Common Tern. It was feeding along the entire length of the beach, during which pictures were taken. After a few minutes, it settled on a fallen coconut trunk on the beach, and more pictures were taken from a distance of about 10 m. From the images, the identity of the bird was confirmed as the Common Tern, this sighting being the first record of the species from the Andaman & Nicobar Archipelago.

The Common Tern can be separated from the similar Arctic Tern *S. paradisaea* by its longer and thicker bill, broader dusky trailing edge to outer primaries on under-wing, and the shorter outer-tail feathers that do not reach the tail tip. From the Roseate Tern *S. dougalli*, it can be separated by the shorter tail, and presence (absence in Roseate) of dark trailing edge to primaries on under-wing and dusky shoulder carpel bar. The Roseate Tern also has a long, fine and slightly downward curved bill. From the smaller White-cheeked *S. repressa*, the Common Tern can be easily separated by the whitish (*vs.* grey in White-cheeked Tern *S. repressa*) rump.

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6. SIGHTING OF GREATER SCAUP *AYTHYA MARILA* AND PALLID SCOPS-OWL *OTUS BRUCEI* IN EASTERN KACHCHH OF GUJARAT, INDIA

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Gujarat, the westernmost state of India, is an important area for resident, wintering, and passage migrant birds because of its diverse habitats, unique geographical location, tradition of conservation, and as part of the migratory route of birds

(Khacher 1996). The deciduous and thorn forests, grasslands, wetlands, marine intertidal areas, scrublands, and saline deserts of Gujarat (Singh 2001) support more than 490 species of birds, including some stray and unconfirmed records (Grimmett and Inskipp 2003). Kachchh is one of the most important districts of Gujarat because of its high biodiversity value (Geevan *et al*. 2003). Kachchh is well-represented by resident and migratory species of terrestrial and wetland birds, including several globally threatened species. The avifauna of Kachchh is documented since the British period to date, and the major studies include Madansinhji (1949), Ali (1960) Maharao of Kutch (1968), Prakash (1974), Tiwari (1997), Varu (1991, 2009), and Munjpara and Gadhvi (2012) have published accounts of the avifaunal diversity of Kachchh district.

We conducted avifaunal surveys in eastern Kachchh district between October 2011 and May 2014, around Bachau (23° 17′ 22″ N; 70° 20′ 42″ E), Samakhiali (23° 18′ 74″ N; 70° 30′ 70″ E), and Jangi (23° 13′ 36″ N; 70° 33′ 71″ E) as part of our research project "Impact of wind farm on birds and bats". The climate of the area is arid and semi-arid. The temperature is high in most of the months, reaching 40–46 °C during May–June, and 12–15 °C during December–January. The mean annual rainfall received during the south-west monsoon between June and September is 400 mm.

A total of 173 species of birds belonging to 44 families were recorded, which included four Vulnerable and eleven Near Threatened (BirdLife International 2015) species. During the surveys, two records were significant; the details of which are given below.

Greater Scaup *Aythya marila*

On May 23, 2013, a pair (male and female) of Greater Scaup was observed in a freshwater pond in Samakhiali (23° 18′ 10″ N; 70° 30′ 42″ E). Though the pond also had large numbers of Spot-billed Duck *Anas poecilorhyncha*, Common Coot *Fulica atra*, Little Grebe *Tachybaptus ruficollis*, Little Cormorant *Phalacrocorax niger*, and Darter *Anhinga melanogaster*, Greater Scaup did not associate with them during our observations. The following description is based on notes made during the observation:

Male: Head, neck, breast and tail greenish black with bright yellow eyes. Bill grey and slipper-shaped. Flank, mantle and back grey. *Female*: Head, neck and chest unmarked brown with a prominent white patch surrounding the bill.

Greater Scaup breeds across the northern limits of Europe (including Iceland) and Asia, through Aleutian Islands (year-round breeding) to Alaska (USA), and across the Atlantic coast of Canada. It winters along the coasts of North America (Atlantic and Pacific), northwest Europe, Black and Caspian Seas, Japan, and the Yellow and East China Seas (del Hoyo *et al*. 2005a). Two subspecies, *A. m. marila* and *A. m. mariloides* have been recognized (del Hoyo *et al*. 2005a). Of these, *A. m. marila* is a vagrant or rare winter migrant to India (Kazmierczak 2000; Grimmett *et al*. 2011), but we observed it in summer. Winter sightings of this species in India have been reported from Bombay Deccan (Aspinall 1950), Corbett National Park, Uttarakhand (Kumar and Lamba 1985), Dihaila Jheel, Karera Bustard Sanctuary, Madhya Pradesh (Natarajan and Sugathan 1987), Nelapattu Bird Sanctuary, Andhra Pradesh (Prashant *et al*. 1994), Assam (Bhagabati and Lahkar 1998; Choudhury 2000), Sikkim (Ganguli-Lachungpa 2002), Pohara-Malkhed Reserve Forest, Maharashtra (Wadatkar and Kasambe 2002), Nagpur (Kedar 2012), Okhla Barrage (Vyas 2002), Pong Dam, Himachal Pradesh (den Besten 2004), Bhindawar Bird Sanctuary, Haryana (Harvey *et al*. 2006) and Yamuna river (Harvey *et al*. 2006). In Gujarat, Dharmakumarsinhji (1935, 1973) recorded it in Bhavnagar district, and since then there has been no authentic record of this species from Gujarat (Grimmett *et al*. 2011; Kazmierczak 2000; Rahmani and Islam 2008). This is a report of Greater Scaup from Gujarat after 40 years, and the first record for Kachchh district. However, recently, Shivkar and Vaze (2014) recorded this species at Thol Bird Sanctuary, Gujarat.

Pallid Scops-Owl *Otus brucei*

On February 05, 2013, a dead Pallid Scops-Owl was found under a wind turbine at Jangi (23° 13′ 52″ N; 70° 34′ 14″ E). The bird was fresh; we noted the following characters:

Overall plumage grey with small ear-tufts on the round head. Upper- and underparts with sharp black streaks with thick longer streaks on breast side. Facial disc pale and plainer and bright yellow eyes with short whitish eyebrows. Bill brown with white bristles at sides, feet light grey.

The Pallid Scops-Owl is resident in south-eastern Arabia and Iran, and winter in Turkey, Iraq, north-eastern Egypt, Arabia, Afghanistan, Pakistan and north-western India (König *et al*. 1999). It usually prefers cultivated areas, riverine woodlands, stony semi-deserts, steep cliffs, and rocky gorges where trees grow larger than bush size (Voous 1988). Its status in India is described as "rare visitor" by Kazmierczak (2000), Grimmett *et al*. (2011) and del Hoyo *et al*. (2005b). Wintering distribution of Pallid Scops-Owl in India has been reported from different regions of Maharashtra (Abdulali 1972; Prasad 2003, 2006), Ambala, Haryana (Roberts 1992), and Ladakh (Pfister 2001). In Gujarat, the bird has been recorded at Saurashtra (Dharmakumarsinhji 1955), Rajkot (Mundkur 1986), and recently at Zainabad of Little Rann of Kachchh, Surendranagar district (Sangha and Malik 2010). However, there are many photographic sight records of this species from different regions of Gujarat

(http://orientalbirdimages.org/and http://ibc.lynxeds.com).

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7. FIRST PHOTOGRAPHIC RECORD OF NEST OF INDIAN REED-WARBLER *ACROCEPHALUS* (*STENTOREUS*) *BRUNNESCENS* FROM NAVI MUMBAI, MAHARASHTRA, INDIA

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Indian Reed-warbler *Acrocephalus* (*stentoreus*) *brunnescens* is a winter visitor, passage migrant, and breeder in the Indian subcontinent. It winters over most of the Subcontinent and breeds mostly in north-western India, especially in Srinagar valley, Kashmir, Punjab, Uttar Pradesh, Rajasthan, as well as Baluchistan and Sind areas of Pakistan (Rasmussen and Anderton 2012). It has been recorded breeding regularly in Vembanad lake, Kerala (George 1961), in southern India. It is mentioned as a very noisy and abundant bird found in the mangroves of Mumbai during the breeding season from May to August (Ali and Ripley 1983). Abdulali (1981) and Prasad (2003) have mentioned this species as a migrant, but with some breeding in Maharashtra.

This species has been recorded throughout the year in Mumbai and adjoining areas, and is believed to be breeding here (Ali and Ripley 1983). Dr. Sálim Ali collected a specimen of Indian Reed-warbler on April 02, 1930, from Rewas, Raigad district, and found that the testes of the male were sufficiently large to suggest that the birds were at their breeding station (Whistler 1931). Dr. Sálim Ali also stated that this species certainly breeds in the mangroves of Rewas river, which extends along the Dharamtar Creek. He made several attempts to procure nests and eggs from this locality, but was unsuccessful due to the nature of the terrain and density of vegetation. On May 06, 1931, at Mahul (Trombay Island), he found males exhibiting excited and noisy behaviour (Anon. 1931). But no nesting of Indian Reed-warbler has been reported from Maharashtra till date.

In Navi Mumbai area, in the west coast state of Maharashtra, the Indian Reed-warbler has been sighted in all mangrove areas since January 2012 (Narwade *et al.* 2012). The calls of this bird were heard often, but the birds were sighted only occasionally, perched on mangroves and associated plants. While surveying the mangrove area in April 2014 at Pargao-Dungi villages (19° 0′ 8.68″ N; 73° 3′ 54.86″ E), near Kalundre river and Panvel creek in Navi Mumbai, Maharashtra, we observed high activity of the Indian Reed-warbler. These birds were found calling continuously from several directions, which prompted us to conduct more visits during its breeding season, monsoon. On June 30, 2014, at 9:30 hours, a bird was observed sitting in a nest shaping it properly in the mangroves of Pargao village (Fig 1). The nest was cup-shaped, made with fine grass, and was found on *Avicennia marina*, 1.2 m (4 feet) above the ground. The nest was well-hidden in the mangroves, so only a few record shots could be obtained without disturbing the nest. A similar looking nest was located 1.5 m (5 feet) from the first nest. On visiting the site again in the subsequent week, due to the thick growth of mangrove associated plants, the nest could not be seen as the place was inaccessible. This nesting record is evidence that Indian Reed-warbler breeds in Mumbai and adjoining areas.

MRUGANK PRABHU

Fig 1: Nest of Indian Reed-warbler *Acrocephalus* (*stentoreus*) *brunnescens* in Navi Mumbai

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8. FIRST RECORD OF THE BLUE-FRONTED REDSTART *PHOENICURUS FRONTALIS* IN CENTRAL INDIA

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On December 02, 2014, at 08:22 hrs, a bird with prominent blue colour, pale orange belly and broad black T-pattern on tail was spotted sitting on a tree in Khitauli region beat/compartment (gate) of the Bandhavgarh Tiger Reserve (23° 42′ 26.773″ N; 80° 54′ 5.3856″ E). Suddenly it flew to the ground, picked up something and returned to the tree. It was observed for 15 minutes, but could not be identified in the field. Later, on literature survey, the characters observed confirmed the bird to be Blue-fronted Redstart *Phoenicurus frontalis*. As this is the only species of redstart with a broad black T-pattern on the tail, the identification was confirmed.

The Blue-fronted Redstart is a member of the family Muscicapidae. It is resident in the Himalaya from north-east Afghanistan and north Pakistan to north-east Arunachal (Grimmett *et al.* 2011), summering at 2,700–4,900 m. In winter it extends its range to the south Assam hills, wintering at 1,000–3,000 m (Rasmussen and Anderton 2005). So far, there have been no records of Blue-fronted Redstart from Central India. Blue-fronted Redstart is being reported for the first time in Central India (Bandhavgarh Tiger Reserve) in this note. Further systematic surveys can assess the distribution and status of the species in and around Bandhavgarh Tiger Reserve, Madhya Pradesh, and the possibility of vagrant or migrant status of the bird can be explored.

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9. BAYA WEAVER *PLOCEUS PHILIPPINUS* (LINNAEUS, 1766) NESTING ON BOTTLEBRUSH TREES *CALLISTEMON* IN JODHPUR, RAJASTHAN, INDIA

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Three species of weavers, namely Black-breasted Weaver *Ploceus benghalensis*, Streaked Weaver *P. manyar*, and Baya Weaver *P. philippinus* are reported from Rajasthan (Ali and Ripley 1987). Of these, the nests of the Baya Weaver have been recorded from 84 species of trees and shrubs represented by both indigenous and exotic tree species, and 20 fibre-yielding plants are known to be utilized by the bird for nest making (Sharma 1995).

The exotic bottlebrush tree *Callistemon* spp., a native to Australia, has been introduced as a garden tree and also naturalized in many countries. It is a member of the family Myrtaceae and is represented by about 34 species. We recorded for the first time two species of bottlebrush, namely *Callistemon citrinus* (Curtis) Skeels (Synonym: *C. lanceolatus*) and *C. viminalis* (Gaertn.) G. Don (Synonym: *Melaleuca viminalis*), being used as nesting sites by the Baya Weaver in Jodhpur, Rajasthan, India (Eds: photographic evidence provided). We observed large numbers of their nests on these two bottlebrush species every year since 2009: *Callistemon viminalis* tree was utilized yearly (2009–2015) and *C. citrinus*, for only two years (2009 and 2010). It was observed that nesting continued on the tree that was near a small permanent artificial water tank in the garden area, unlike the tree that was far from the water source.

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10. A REPORT ON THE EXOTIC MOONLIGHT GOURAMI *TRICHOPODUS MICROLEPIS* GÜNTHER (PERCIFORMES: PERCOIDEI: OSPHRONEMIDAE: LUCIOCEPHALINAE) FROM CHALAKUDY RIVER, KERALA, INDIA

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Trichopodus microlepis Günther 1861 is a labyrinth fish of family Osphronemidae native to Mekong river in Cambodia (Rainboth 1996), Vietnam and Chao Phraya basin (Kottelat 2001). This species has also been introduced into the Mekong basin in Thailand (Froese and Pauly 2014; Monkolprasit *et al.* 1997), Singapore (Ng *et al.* 1993), Taiwan (Liang *et al.* 2006), Colombia and South America (Welcomme 1988). *T. microlepis* is found in ponds and swamps or shallow, sluggish or standing water with a lot of aquatic vegetation (Kottelat 2001).

Several species of family Osphronemidae have been reported from India: *Pseudosphromenus cupanus* (Beevi and Ramachandran 2009; Baby *et al.* 2011; Manakadan *et al.* 2009; Narayanan *et al.* 2005; Rema Devi *et al.* 2005), *Trichogaster fasciata* (Keishing and Vishwanath 1999); *Trichogaster lalius* (Manakadan *et al.* 2009; Ramanujam *et al.* 2014); *Pseudosphromenus dayi* (Beevi and Ramachandran 2009). *Trichopodus trichopterus* and *Osphronemus goramy* (Ramanujam *et al.* 2014) are the two exotic species reported. However, there is no report of *Trichopodus microlepis* from India so far. In this note, we report the presence of Moonlight Gourami *T. microlepis* from the freshwaters of Kerala. One specimen was collected from the lower reaches of Chalakudy river at Kanakkankadavu (11° 17′ 24.6″ N; 76° 10′ 5.7″ E),

Ernakulam, on April 12, 2014. The fish was collected by cast net, preserved in 10% formaldehyde and deposited in Maharaja's College Zoology Museum with accession No. MCZMF 377.

The specimen was identified based on Topfer and Schindler (2009), Paepke (2009), and Low and Lim (2012) (Eds: photographic evidence provided). The specimen had a total length (TL) of 155 mm and standard length (SL) 121 mm, dorsal fin with 4 spines and 8 rays; pectoral fin with 9 rays; ventral with one long filament and 2 rays; and anal fin with 11 spines and 36 rays, predorsal scales 48 and 62 scales on lateral series. Body laterally compressed and elongated, very deep, body depth 47.9% of SL. Head and body covered with small ctenoid scales. Head moderately large, head length 30.5%, width 15.7%, and depth 17.3% of SL, nape distinctly concave. Eyes small, eye diameter 21.6%, snout length 32.4% and inter-orbital width 40.5% of HL. Mouth superior, slightly protractile, lips well-developed. Opercle and inter opercle not serrated. Single dorsal fin inserted posterior to the midpoint of body, with 4 spines and 8 branched rays, dorsal fin length 20.6% and base 14.8% of SL. Pectoral fin with 9 rays, pectoral length 28% and base 4.1% of SL. Ventral fins inserted a little anterior to pectoral, with 3 rays, first ray is a 135 mm long, thread-like filament extending far beyond the caudal fin. Anal fin with 11 spines and 36 rays, anal fin length 15.7% and base 70.2% of SL extending the whole length of belly up to caudal fin but not confluent with it. Caudal fin emarginate, deflected downwards with 18 strong, branched rays, its length 27.2% of SL. Caudal peduncle very short with a feeble black spot. Lateral line incomplete, 62 scales on lateral series. Body has an even silvery sheen created by its small scales, tinted with a green iridescence on the dorsal side. All fins with a yellowish tinge except pelvic fins, which are colourless. Caudal fin with a striated appearance due to transverse rows of small black spots.

Only four species of the genus *Trichopodus* Lacepède, 1801 of family Osphronemidae are so far known: *T. trichopterus*, *T. leerii*, *T. microlepis*, and *T. pectoralis* (Paepke 2009). The concave slope of the head and the long ventral fin filaments distinguish *T. microlepis* from its congeners. The silvery greenish hue of the body, like the soft glow of moonlight, gives it the name Moonlight Gourami (Hargrove 2011). Meristics vary among the four species: 4 spines and 8 rays on dorsal fin in *T. microlepis* vs 6–8 spines and 8–9 rays in *T. trichopterus*, 7 spines and 10–11 rays in *T. pectoralis*, 5–7 spines and 8–10 rays in *T. leerii*. 62 scales in lateral series in *T. microlepis* vs 40–52 scales in *T. trichopterus*, 55–63 scales in *T. pectoralis*, and 44–50 scales in *T. leerii*. Anal fin with 11 spines and 36 rays in *T. microlepis* vs 10–12 spines and 33–37 rays in *T. trichopterus*, 9–11 spines and 36–38 rays in *T. pectoralis*, and 12–14 spines and 25–30 rays in *T. leerii* (Paepke 2009). *T. microlepis* is a well-known food fish (Ukkatawewat 1984), and an aquarium species as it shows distinct sexual dimorphism: male with orange or red pelvic fins and long pointed dorsal fin, female with colourless pelvic fins and round dorsal fin. It is reared in captivity for ornamental purposes (Elson and Lucanus 2002; Linke 1991; Paepke 2009; Pinter 1986).

"Invasive alien species of fish that have taken advantage of the aquarium trade are emerging as the most important threats to fragile aquatic habitats according to Knight (2010)". Recovery of many exotic aquarium fishes from the natural waters of Kerala has been reported by Ajithkumar *et al.* (1998) and Bijukumar (2000). The exotics Goldfish *Carassius auratus* (Rema Devi 1987), Red Piranha *Pygocentrus nattereri* (Bijukumar 2000), Guppy *Poecilia reticulata*, the Mosquitofish *Gambusia affinis* (Daniels 2002; Krishnakumar *et al.* 2009), Mozambique Tilapia *Oreochromis mossambicus*, Common Carp *Cyprinus carpio*, Grass Carp *Ctenopharyngodon idella* (Daniels 2002), Loricariid catfish *Plecostomus* sp. (Daniels 2002), Southeast Asian Three spot Gourami *Trichopodus trichopterus* (Daniels 2006), Sword Tail *Xiphophorus maculatus*, Giant Gourami *Osphronemus goramy* (Krishnakumar *et al.* 2009; Raghavan *et al.* 2008a,b), *Pterygoplichthys multiradiatus* (Daniels 2006; Krishnakumar *et al.* 2009; Ramanujam *et al.* 2014) have started establishing local populations throughout peninsular India. Around Chennai, native Gourami *Trichogaster lalia* tends to coexist with the Three spot Gourami *Trichopodus trichopterus* (Daniels 2006). Unregulated introduction and farming of exotic species are negatively impacting the native aquatic biodiversity (Krishnakumar *et al.* 2011 ; Raghavan and Prasad 2006; Singh and Lakra 2006). *T. microlepis* collected from Chalakudy river might have reached natural waters from the aquarists accidentally. The present study highlights the report of exotic Moonlight Gourami *Trichopodus microlepis* in the natural waters of Kerala.

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11. BLUE GLASSY TIGER *IDEOPSIS SIMILIS PERSIMILIS* (MOORE 1879) – FIRST RECORD FOR INDIA FROM NAMDAPHA NATIONAL PARK, ARUNACHAL PRADESH

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Introduction

The Blue Glassy Tiger *Ideopsis similis persimilis* (Moore 1879) is known to occur in Myanmar, southern China, Thailand, Laos, Cambodia, Vietnam, Malaysia (in Langkawi and Kedah), Sumatra (Savela n.d.; Yutaka 2015) and Sri Lanka (Evans 1932). It is common throughout its range. It was treated as *Danais similis* in Evans (1932), where subspecies *persimilis* was treated as *Danais similis vulgaris*, and in Talbot (1947) as *Danaus similis persimilis* (Moore). Wynter-Blyth (1957) also mentioned that it is not found in India. So far there has been no record of this species occurring on the Indian mainland, though it is common in the adjoining Myanmar.

The subspecies *Ideopsis similis exprompta* (Butler) occurs in south-west Sri Lanka and is not rare there (Gasse Paul Van 2013).

Material and Methods

During a BNHS Nature Camp on October 12, 2014, at 12:45 hours, one individual of Blue Glassy Tiger was seen near Haldibari route in the drying riverbed of Noa-Dihing in Namdapha National Park (27° 29′ 00″ N; 96° 23′ 00″ E). This Park is located in Changlang district of the north-eastern state of Arunachal Pradesh, near its border with Myanmar. The butterfly was mud-puddling alone. Later it took off to visit flowers of *Bidens pilosa*. After nectaring, it flew further along the edge of the river bank among low vegetation.

It was immediately distinguished from other species of milkweed butterflies (Danainae) by the forewing, which has a broad streak in the cell and an outwardly dented, detached spot; a slender costal streak above the cell; two large discal spots inwardly pointed; three long spots beyond the cell apex; four or five subapical spots; a series of spots along the wing margin, decreasing in size towards the apex. A short, slender streak along the dorsum (inner margin); and above that in space 1b, two broad streaks united at the base, the upper one curved. These characteristic markings were clear enough to establish the identity of the species. The images were later compared with the illustration in Talbot's FAUNA OF BRITISH INDIA, vol. 2 and they matched well.

The nearest known population of this species is in Myanmar, which is within 100 km from the current location. The butterfly's distribution ranges through Southeast Asia from Myanmar eastwards, where it is commonly seen throughout the year.

Remarks

The present sighting extends the known distribution of this butterfly to the Indian mainland. It was recorded in March (1983, 1987, 1992) several times and once in November (1990) in Thailand (Yutaka 2015). The current record confirms that it is on the wing in October.

After searching the area, we found that this was the only individual flying. The presence of only one individual in the area suggests that it could probably be a straggler that had strayed during migration, or there could be a sizable breeding population in the area close by. The behaviour of this individual clearly indicated that it was localized in the area along the drying river bed. Therefore, there is need to confirm whether this butterfly breeds in this area and thereby one can establish its seasonality in India.

Though this butterfly is common over most of its known distribution range, the fact that it was only discovered now is probably because no one had really looked for it in this area earlier, and it can be easily mistaken for a Glassy Tiger *Parantica aglea* (Stoll) or Blue Tiger *Tirumala limniace* (Cramer). The possibility of adding this species to the butterfly fauna of India will require the discovery of further individuals, so more surveys should be conducted in the region bordering Myanmar.

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12. SCARCE BLUE TIGER *TIRUMALA GAUTAMA GAUTAMA* (MOORE, 1877) – FIRST RECORD IN THE ANDAMAN ISLANDS, INDIA

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Introduction

The Scarce Blue Tiger *Tirumala gautama gautama* (Moore 1877) is known to occur in Myanmar, Thailand, Laos, Cambodia, southern Vietnam, Hainan, China, and northern Malaysia (in Langkawi) (Yutaka 2015). It is treated as *Danais gautama gautama* in Evans (1932), where the distribution is reported as Myanmar (Burma) and the status is given as "Rare". In Talbot's Fauna of British India, Vol. 2, this species is treated as *Danaus gautama gautama* (Moore), and the distribution is from Myanmar eastwards. Even in the earliest published record [Ferrar (1948)] there have been no records of this subspecies from the present Indian political boundary (Khatri 1993; Veenakumari *et al*. 2008).

The subspecies *Tirumala gautama gautamoides* (Doherty) occurs in Nicobar Islands and is known to be very rare there (Talbot 1947).

Material and Methods

During a BNHS Nature Camp in March 2010, one individual (male) of Scarce Blue Tiger was seen on a Rattlepod plant (*Crotalaria* sp.) at Kalipur, North Andaman (13° 13′ 31″ N; 93° 2′ 50″ E) with one Blue Tiger *Tirumala limniace* (Cramer). Three days later, another individual was seen on Common Floss flower (*Chromolaena* sp.) nectaring with a Blue Tiger. I almost mistook both these butterflies for Blue Tigers, but later while photographing them at close range I saw the difference in the forewing cell markings. The images were later compared with the images on the website Butterflies of Indo-China (Yutaka 2015) and with the description in Talbot's Fauna of British India, vol. 2, and they matched well.

On comparing the description, the specimen was immediately distinguished by the markings on the forewing, which has two narrow streaks in the cell, joined at the base, and an irregular spot, sometimes divided into three, at the apex; the upper of the two basal streaks is longer and may extend to the apical spot; a curved discal series of streaks, an irregular, somewhat crooked submarginal row of spots, and a regular series of marginal dots.

The subspecies *Tirumala gautama gautamoides* (Doherty) which occurs in Nicobar Islands differs in being smaller (75–85 mm) than *Tirumala gautama gautama* (90–100 mm). The main difference is in the forewing cell streaks, where the Nicobar subspecies has a very short upper streak which is ill-defined (Eds: photographic evidence provided).

From the current location, Myanmar and Thailand are the nearest known localities (between 700–800 km) of this subspecies on the mainland. The butterfly's known distribution range is in Southeast Asia from Myanmar eastwards.

Remarks

The present sighting extends the known distribution of this subspecies to India. It was recorded on the wing in November in Vietnam (Yutaka 2015). The current record indicates that it is on the wing in March also.

On both the days I found only a single individual, and the behaviour of this individual clearly indicated that it was localized and there could be a sizable breeding population in the area. Most of the activity was nectaring around the Common Floss flower (*Chromolaena* sp.) and only once was it seen on the Rattlepod plant (*Crotalaria* sp.). There is a possibility of this species being recently

established after being blown to the island during the Tsunami of 2004.

There is a need to confirm whether this butterfly breeds in this area, and thereby one can establish its seasonality in India. Also, there is a possibility of its addition to the butterfly fauna of India if more surveys could be conducted to confirm the continued presence of this species in India.

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13. RANGE EXTENSION OF LESSER THREE-RING *YPTHIMA INICA* HEWITSON (1864) (LEPIDOPTERA: NYMPHALIDAE) SOUTHWARDS TO THE NORTHERN WESTERN GHATS, INDIA

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Introduction

The Lesser Three-ring *Ypthima inica* Hewitson (1864) is known to occur in India from Punjab to West Bengal (Evans 1932; Talbot 1947). The southernmost distribution of this species is up to Mhow in the Indore district of Madhya Pradesh, and from Bengal in the east to Punjab in the west (Wynter-Blyth 1957). This species is confined to the northern plains of India at low elevations. Van Gasse (2013) mentions its distribution in the Indian subcontinent as from the NWFP (Bunna) and northern Punjab (Lahore region) of Pakistan through Amritsar and Delhi region to Garhwal, central and eastern Nepal terai, and West Bengal (Malda district), south to Madhya Pradesh and Chhattisgarh, and northern Myanmar (Bhamo).

Material and Methods

On December 06, 2010, while photographing butterflies in a garden near Dombivli (East), Mumbai (19° 12′ 29.748″ N; 73° 05′ 16.681″ E), I spotted a drab brown butterfly sucking moisture from a leaf. I photographed it and later while comparing its images, noted that it appeared different from other species of the *Ypthima* group known from the area. The butterfly appeared very similar to Common Three-ring *Ypthima asterope* (Klug), however on further comparison it was identified as Lesser Three-ring *Ypthima inica* Hewitson (1864). It differed from *Ypthima asterope* in having one large apical and two smaller eyespots at tornus on under hindwing and the apical eyespot not in line with eyespots at the tornus, whereas *Ypthima asterope* has two small eyespots near tornus on under hindwing, and often a third smaller eyespot may be present near the apex.

So far, two species of *Ypthima*, namely Common Four-ring *Ypthima hubneri* and Common Five-ring *Ypthima baldus* have been found all over the city. *Ypthima inica* has not been reported from Mumbai region earlier, thus this is the first record of its occurrence from Mumbai region in Maharashtra on the western coast of India.

Remarks

The present sighting extends the known distribution of *Ypthima inica* up to northern Western Ghats on the west coast of India. While this note was being prepared, it was brought to the author's notice that similar sightings of this species were recorded in Thoseghar, Satara district in Maharashtra by Milind Bhakare on October 06, 2010 and on November 03, 2010 by Paresh Kale in Harishchandragad, Ahmednagar district in Maharashtra.

After surveying the area in and around Dombivli several times, I have found only one individual so far. The presence of only one individual in the area suggests that it could be a straggler that had strayed during migration or

there could be a sizable breeding population in the area close by. Therefore, there is a need to confirm its recurrence in this area to find out its status in the new extended habitat.

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14. CANNIBALISTIC BEHAVIOUR IN THE MANGROVE CRAB *PARASESARMA PLICATUM* (LATREILLE, 1803)

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Crabs are mostly herbivores, but they are also opportunistic carnivores (Bliss *et al.* 1978). Cannibalistic behaviour has been reported from economically important species like *Scylla serrata* (Forskål) and *S. tranquebarica* (Fabricius) (Baliao *et al.* 1981; Cholik and Hanafi 1992). While studying the factors influencing the coexistence of *Parasesarma plicatum* and *Helice tridens*, Kuroda *et al.* (2005) happened to refer to cannibalism in a subadult population of *P. plicatum*, though they did not elaborate on this behaviour. Otherwise, there are no reports on cannibalism exhibited by this species. We provide here, for the first time, the entire sequence of cannibalistic behaviour of *P. plicatum* documented in the laboratory of our field station in Kunhimangalam, Kannur district of Kerala, India. *P. plicatum* which is widely distributed in Indo-West Pacific region (Rahayu and Ng 2010), inhabits marshy intertidal areas with frequent tidal inundation.

Sixty adult crabs were handpicked at random (41 males and 19 females) from Kunhimangalam mangrove forests (12° 15′ N; 75° 13′ E) during low tide. The carapace width and wet weight of crabs were recorded. A total of six tubs (T1–T6) were maintained with 10 crabs per tub. Male to female ratio of the crabs used for the experiment was assessed (Table 1). Of the six tubs, three were maintained with equal amount of decomposed and senescent mangrove leaf litter (25 gm each) of *Aegiceras corniculatum*, *Avicennia officinalis*, *Excoecaria agallocha*, and *Rhizophora mucronata* as these represented the dominant litter contributing species in the study area (Nayar 2011). The remaining three tubs were maintained without leaf litter. The situation was closely and progressively monitored for the next five days.

We used only adult crabs for the experiment. Carapace width ranged from 14 to 21 mm for females and 13 to 24 mm for males (Table 2), with an average carapace width of 17.77±2.2 mm (n=60, Mean±SD). Males and females did not show any significant size difference in carapace width. Average wet weight was 3.56±1.36 gm. *P. plicatum* showed

Table 1: Male : Female ratio before and after the experiment

Tub no	Type of treatment	Male : Female ratio before experiment	Male : Female ratio after experiment
1	without litter	8:2	2:0
2	without litter	6:4	5:1
3	without litter	8:2	4:0
4	with litter	8:2	4:2
5	with litter	6:4	4:2
6	with litter	5:5	5:4
Total		41:19	24:9

cannibalistic behaviour in two ways: (1) a deliberate attack by one crab on a seemingly weaker one, (2) when two crabs accidentally came across each other.

The attack was either frontal or side to side. Frontal (face to face) attack started with both the crabs exhibiting a threat posture by standing on their walking legs and widely stretching the chelipeds towards the opponent as shields. This was followed by a full contact attack with the chelipeds. This lasted for 10 to 120 minutes until the 'attacked' crab succumbed. The 'succumbed' crab was then mass attacked by the surrounding crabs. During the mass attack, no crab played the role of a leader. Some crabs cut the victim's carapace from the base of the abdomen and removed it to expose the soft internal tissues. The prey could be still alive moving its legs and chelipeds. After this, three or four crabs attacked the body of the prey and fed on the fleshy matter. Some sliced pieces of flesh and took them away from the spot to feed comfortably, while others attacked the eyes at the base of the stalk, making the prey completely blind. The crabs that did not get an opportunity to climb over the body and eat the flesh satisfied themselves by attacking the walking legs of the 'succumbed' crab. They detached the walking legs from the body and took them away to a distance to feed on them undisturbed. The flesh attached to the proximal end of the cheliped was also consumed. The leftovers, after consuming the edible parts, included ventral exoskeleton, one to four walking legs, abdominal flap, cheliped, and detached carapace. The duration of this cannibalistic feeding was two

Table 2: Sex, carapace width and wet weight of crabs used in the experiment

Sl no.	Sex	Carapace width (cm)	Wet weight (gm)	Sl no.	Sex	Carapace width (cm)	Wet weight (gm)
1	Female	2.1	4.2	31	Male	2.0	4.3
2	Male	1.8	3.5	32	Male	1.7	2.7
3	Male	2	5.4	33	Male	1.8	3.7
4	Male	2.2	5.3	34	Male	1.8	3.8
5	Male	1.8	3.2	35	Male	2	5
6	Male	1.9	3.9	36	Male	2.0	5.1
7	Male	1.8	3.6	37	Male	1.9	4.7
8	Male	1.8	3.6	38	Male	1.8	3.6
9	Male	1.8	3.5	39	Male	1.8	3.2
10	Male	1.7	2.8	40	Male	2.0	4.7
11	Male	1.8	3.7	41	Male	1.5	2.2
12	Male	1.7	3	42	Male	1.6	2.8
13	Male	1.7	3.6	43	Female	1.6	2.6
14	Male	1.8	3.4	44	Female	1.4	2
15	Male	1.5	2.2	45	Female	1.4	1.7
16	Male	1.6	2.8	46	Female	1.5	2.3
17	Male	1.5	2	47	Female	1.8	4
18	Male	1.5	1.7	48	Female	2	4.7
19	Male	1.3	1.7	49	Female	1.7	3.7
20	Male	1.8	3.2	50	Female	1.8	3.8
21	Male	2.0	4.6	51	Female	1.5	2
22	Male	1.7	6.4	52	Female	1.6	2.5
23	Male	2.4	7.8	53	Female	1.6	2.5
24	Male	1.5	2.1	54	Female	1.8	3.7
25	Male	1.8	3.2	55	Female	1.8	3.8
26	Male	2.0	5.4	56	Female	2	6
27	Male	1.8	4.1	57	Female	2	5.9
28	Male	1.5	1.7	58	Female	1.7	2.3
29	Male	2.0	4.4	59	Female	1.6	2
30	Male	1.8	3.4	60	Female	1.5	2

Fig 1: (a) Population of *Parasesarma plicatum*, (b) *P. plicatum* feeding on a detached cheliped, (c) *P. plicatum* with its carapace detached by the attack of conspecifics in the laboratory experiment, (d) Remnants of *P. plicatum* prey after cannibalism

to four hours. The above sequences were repeatedly observed in the first ten instances (Fig. 1a–d). We recorded only the number of kills since then, for the remaining 17 events.

In side to side attack, two crabs started to fight with their walking legs. This happened normally when two crabs accidentally came across each other. After the initial fight, they gradually came face to face and continued the cannibalistic behaviour as discussed earlier. It was observed that <10% of the attacks ended in a kill. In most instances, after the threat posture, both the crabs avoided encounter and dispersed.

Cannibalism is a common ecological interaction in the animal kingdom and has been recorded in 1,500 species (Polis 1981). It is not only restricted to carnivores, but is also found in herbivores and detritivores (Fox 1975). Cannibalism in *P. plicatum* appears to be based on well-planned strategies, right from the selection of prey to the complete utilization of resources, because they adopted a systematic approach to weaken the prey by first removing one of the most important body parts, the carapace, followed by the removal of eye stalks, thereby blinding it. Moreover, once the carapace is removed, the internal vital organs are exposed and this makes

the prey more vulnerable. Selection of prey is probably an impulse-stimulated behaviour, irrespective of size and sex. It was observed that once the fight started, and if one crab found the other equally strong, the fight normally subsided without leading to cannibalism. Vigorous activity of a comparatively smaller crab could help in successfully overpowering a larger opponent. The attack can be male to male, male to female or female to female. We got 41.46% and 52.63% mortality among the males and females respectively. Lack of food resources can induce the possibility of cannibalism. Out of the 30 crabs in the experimental tubs with leaf litter, nine (30%) succumbed to cannibalism within five days, while in tubs without leaf litter the number was 18 (60%), a twofold increase (Table 1). This showed that lack of food availability enhanced the chances of cannibalism in *P. plicatum*.

Mangrove litter is a major food for most of the mangrove crabs (Nordhaus and Wolf 2007). It has low nutritive value, with less nitrogen content and a higher C : N ratio than is required for herbivores (Allen 1989). Hence, a supply of protein is necessary for the maintenance of normal body activity. Nitrogen, which is essential for rapid growth and high reproductive output, is well-documented as a limiting nutrient resource for herbivores (Wolcott and Wolcott 1984). Scavenging, predation and cannibalism have been reported as the common adaptation among litter consuming crabs to compensate for low nitrogen (Wolcott and Wolcott 1984, 1987, 1988). Cannibalism may be an adaptation in *P. plicatum* to overcome nitrogen deficiency. Fox (1975), Polis (1981), Polis *et al*. (1989), Lovrich and Sainte-Marie (1997), and Amaral *et al*. (2009) observed that cannibalism helped to control population size of crabs. It also promotes minimum intraspecific competition for resources.

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15. *PYCNOCYCLA* LINDL. (APIACEAE): A NEW GENERIC RECORD FOR MAHARASHTRA STATE, INDIA

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Introduction

Genus *Pycnocycla* Lindl. comprises approximately 12 species, distributed from mid Africa to western and central Asia (Mukherjee and Constance 1993). In India, the genus is represented by only a single species, *Pycnocycla glauca* Lindl. which is reported from North West India, Bihar and Madhya Pradesh.

During floristic survey of Nandurbar district,

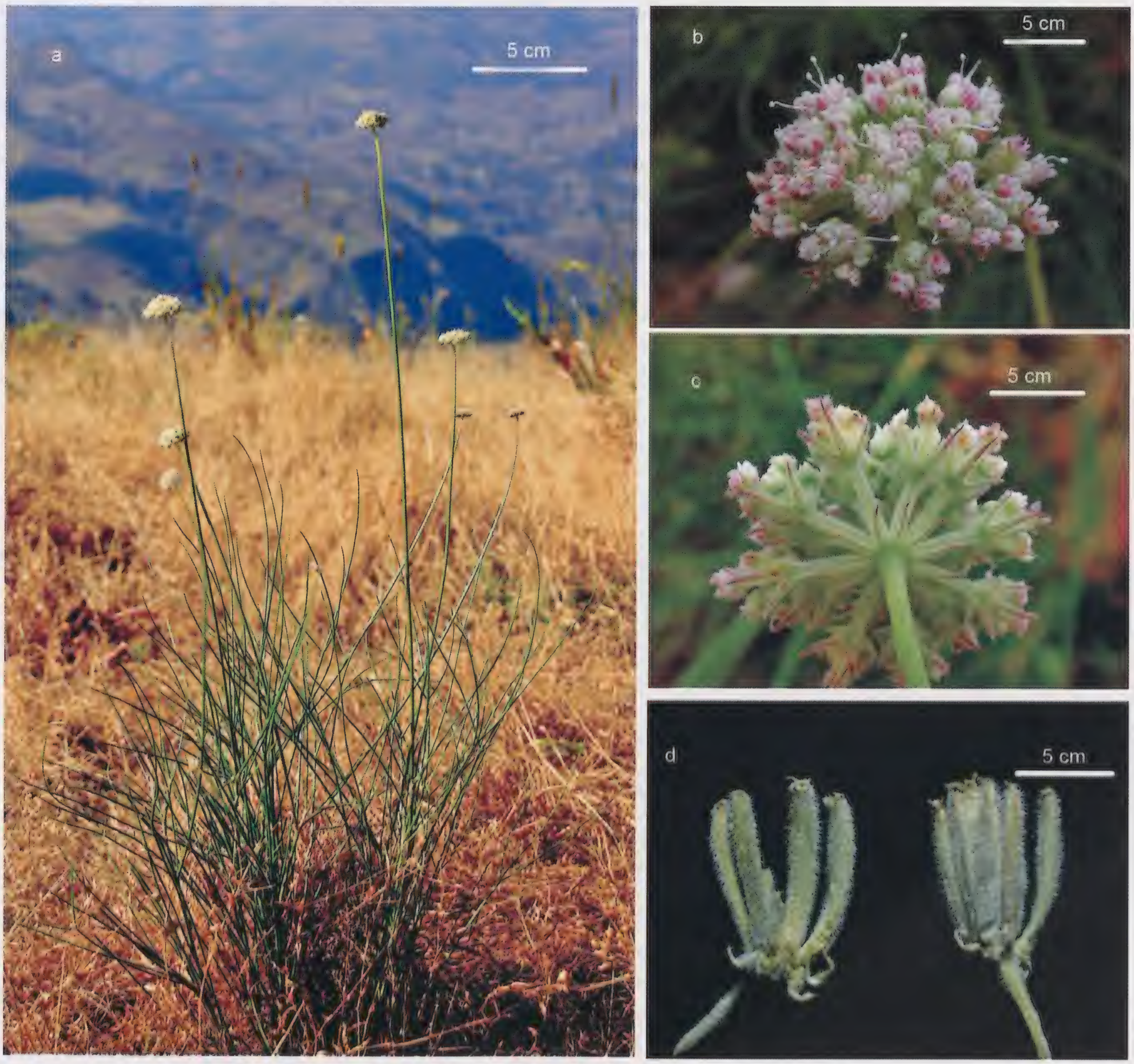

Fig. 1: *Pycnocycla glauca* Lindl. a. Habit; b. Inflorescence top view showing flowers; c. Inflorescence lower view showing involucral bract and bracteole; d. Mature fruits.

Maharashtra, specimens were collected from Astambha in the Satpura ranges, the analyses of which showed that they belong to the genus *Pycnocycla* Lindl. After comparison with literature, the specimens were confirmed as *Pycnocycla glauca* Lindl, with no earlier records of the genus reported from Maharashtra state (Cook 1958; Lindley 1839; Mukherjee and Constance 1993; Singh and Karthikeyan 2000; Verma *et al*. 1993). Thus, it is reported as a new record for Maharashtra state in the present communication.

Pycnocycla glauca Lindl. In Royle, Ill. Bot. Himal. Mount. 232. 1835; C.B. Clarke in Hook. f., Fl. Brit. Ind. 2: 694. 1879. P.K. Mukh., Umbelliferae (Apiaceae) in Ind. 22. 1993., Fl. of Madhya Prad. 521. 1993.

Perennial, rigid, erect, dichotomously branched, pubescent or glabrous, succulent *c*. 60 cm tall herb (Fig. 1). Roots fibrous. Leaves petiolate, pinnate 3, dissected, *c*. 10 cm long, filiform, succulent. Inflorescence compact, compound head-like umbel *c*. 2 cm in diameter. Peduncle 30–50 cm long, terete, hairy. Involucral bracts 9–10, 2–3 mm long, linear, acute, hairy. Rays 20–25, up to 4 mm long at maturity, hairy, terete, bracteoles 6–8, *c*. 2–3 mm long, hairy, acute. Umbellets bearing 7–9 pedicellate staminate male flowers and single sessile central female flower; pedicel *c*. 2 mm long, terete, densely pubescent; sepals 5, evident; petals 5, unequal, 1–2 mm long, white, notched at apex, lobes unequal; stamen 5, exserted with *c*. 4 mm long filament; anthers *c*. 0.5 mm long. Hermaphrodite; pistil single, *c*. 4 mm long (including style), style two, hairy. Fruit elliptic–oblong, villous, 7–9 x 1.5–2 mm; vittae sparsely 3–4 on commissure.

Flowering and fruiting: October to May

Distribution: Ethiopia, Yemen, INDIA: N.W. India, Punjab, Bihar, Madhya Pradesh; Maharashtra (in present communication).

Note: This species is found growing in open grassland on hill slopes at *c*. 1,010 m in Astambha in the Satpura ranges, in association with *Carvia callosa* (Nees) Bremek., *Heteropogon ritchiei* (Hook. f.) Blatt. & McCann, *Arthraxon lanceolatus* Miq., *Artemisia japonica*. Thunb., *Conyza stricta* Willd., *Cymbopogon martini* (Roxb.) Will. Watson, *Eulalia trispicata* (Schult.) Henrard and *Tricholepis amplexicaulis* C.B. Clarke.

Specimen Examined: INDIA: Maharashtra, Nandurbar district, Astambha (21° 40′ 28. 30″ N, 74° 08′ 24.52″ E), 30.xi.2014, Coll.: K.V.C. Gosavi 641 (SUK).

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16. *ENYDRA FLUCTUANS* LOUR. – AN ADDITION TO THE FLORA OF KERALA, INDIA

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Introduction

Enydra Lour. is a pantropical genus of the family Asteraceae with about 10 species (Stuessy 1978), with only one species in India, namely *E. fluctuans* (Patil *et al*. 2008). The plant is well-known for its anti-inflammatory (Sannigrahi *et al*. 2011), analgesic (Rahman *et al*. 2002; Sannigrahi *et*

al. 2011) and anti-diarrhoeal (Uddin *et al*. 2005) properties. The plant was first described from Vietnam in 1790. It was later reported from northern India (Hooker 1897). This taxon was not reported from the erstwhile Madras and Bombay Presidencies, as evident from the absence of this genus in Gamble and Fischer (1936) and Cooke (1908). It was first reported from Maharashtra by Almeida and Daruwalla (1987). The genus *Enydra* is not yet reported from Kerala. This paper reports *Enydra fluctuans* from Shokanashini river in Chittur village of Palakkad district in Kerala. Thus, it is evident that the geographical distribution of the species extends beyond its previously reported range. The specimen has been identified using available floras and monographs. The description is given with notes for easy identification. Voucher specimens were deposited in the herbarium of Malabar Botanical Garden (MBGS) and Calicut University Herbarium (CALI).

***Enydra fluctuans* Lour.**, Fl. Cochinch. 510. 1790; *Enhydra fluctuans* Lour, Hook.f. Fl. Brit. Ind. 3: 304. 1892; Lack. Willdenowia 10: 3. 1980; *Hingtsha repens* Roxb., Hort. Beng. 62. 1814, Fl. Ind. iii. 448. 1832; *Tetraotis paludosa* Reinw. Syll. Pl. Nov. 2: 8. 1825.

Glabrous marsh herb; Stems elongate, simple or divaricately branched, rooting at the nodes; Leaves opposite, linear–oblong, acute or obtuse, base narrowed or truncate, variable in breadth, sessile, glandular; Inflorescence a sessile head, both axillary and terminal; Involucral bracts foliaceous, four in number, in opposite pairs, outer pair larger than the inner; ray florets female, many-seriate, fertile; disk florets with a 5-fid campanulate limb. Cypsela oblong; pappus absent.

Flowering and Fruiting: November to May.

Distribution in India: Assam, Maharashtra, West Bengal, Madhya Pradesh, Bihar, Delhi, Tamil Nadu, Jammu & Kashmir.

Material Examined: INDIA: Shokanashini river, Chittur (10° 41′ 08.5″ N and 76° 43′ 20.6″ E; 97 m above msl) (Palakkad district, Kerala state). Coll.: Sojan and Suresh, 10.iii.2013, MBGS 5457.

Note: A rooted emergent herbaceous hydrophyte that luxuriously spreads over the water surface, competing with *Ipomoea aquatica*, *Eichhornia crassipes*, and *Nymphoides hydrophylla*. It shows complete dominance in the absence of *Eichhornia crassipes* in the river bank region.

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17. *PAPILIONANTHE* SCHLTR. (ORCHIDACEAE) – A NEW GENERIC RECORD FOR CHHATTISGARH, INDIA

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Introduction

The genus *Papilionanthe* Schltr. (Orchidaceae) comprises 11 species distributed in India, China, Southeast Asia and the Malay Archipelago (Mabberly 2008). Of these, 4 species are found in India, *Papilionanthe subulata* (Willd.) Garay, *P. teres* (Roxb.) Schltr., *P. uniflora* (Lindl.) Garay and *P. vandarum* (Rchb.f.) Garay (Misra 2007). The generic name is derived from the latin words *papilio* (butterfly) and *anthos* (flower), an allusion to the butterfly-like flowers in the genus. The genus is characterized by scandent stems, terete leaves, large and showy flowers with distinctly spurred lip.

During a floristic survey of Surguja district, Chhattisgarh in June 2013, specimens of *Papilionanthe* epiphytic on tree trunks of *Shorea robusta* Roth. in Sal forests at *c.* 800 m

altitude were collected from Matranga range. After thorough consultation of the literature and critical examination of the specimens, it turned out to be *Papilionanthe teres* (Roxb.) Schltr., which is hitherto unrecorded from Chhattisgarh (Jha and Khanna 2005; Khanna and Jha 2005; Khanna *et al.* 2005, 2009; Kotia *et al.* 2010, 2013; Kumar 2003; Murti and Panigrahi 1999; Tiwari and Ansari 2014; Verma *et al.* 1985), and hence it is reported as a new record for the state in the present note. The data on correct nomenclature, basionym, relevant synonyms, brief description, phenology, ecological notes along with specimens examined are provided. The specimens are housed in the herbarium of Botanical Survey of India, Central Regional Centre, Allahabad (BSA).

Key to the *Papilionanthe* species in India

1. Flowers solitary or very rarely two, up to 1.5 cm across; side lobes of lip bipartite ..... *P. uniflora*
— Flowers more than two in racemes, 4–10 cm across; side lobes of lip not bipartite 2
2. Flowers *c.* 5–10 cm across; petals orbicular; lip hairy; side lobes of lip rounded ..... *P. teres*
— Flowers 4–5 cm across; petals oblong; lip glabrous; side lobes of lip oblong 3
3. Petals subrhombic; lateral lobes of lip unequally bifid; spur cylindric ..... *P. vandarum*
— Petals oblong; lateral lobes of lip unequally bifid; spur recurved ..... *P. subulata*

Taxonomic Account

Papilionanthe teres (Roxb.) Schltr. in Orchis 9: 78. 1915. *Dendrobium teres* Roxb., Fl. Ind. 3: 485. 1832. *Vanda teres* (Roxb.) Lindl., Gen. Sp. Orchid. Pl. 217. 1833; Hook.*f.*, Fl. Brit. India 6: 49. 1890.

Epiphytic herb. Stems scandent, terete, usually 2–3 m long. Leaves alternate, terete, slender, 8–20 x 0.4–0.5 cm, fleshy, obtuse. Racemes axillary, laxly 2–5-flowered, slightly longer than leaf; peduncle stout, with 3 or 4 membraneous sheaths; floral bracts broadly ovate, 4–6 mm long, slightly fleshy, obtuse. Flowers pinkish, often mixed with white, opening widely, 5–10 cm across. Sepals undulate; dorsal sepals broadly elliptic, blunt; lateral sepals oblong, often with a short spur outside. Petals larger, orbicular; lip yellow or reddish brown, spotted and lined with red and purplish brown, longer than the lateral sepals and adnate to the very short foot, side lobes elliptic; mid lobe clawed, obovate, deeply bifid; spur funnel-shaped, column short, stout, foot very short. Anther 2-celled, rostellum small; pollinia 2, didymous, subglobose; caudicle short, geniculate; gland usually large. Capsules narrowly fusiform.

Flowering & Fruiting: June–August.

Ecological notes: Epiphyte on tree trunks of *Shorea robusta* Roth. in Sal forests around 800 m altitude.

Specimens examined: Chhattisgarh, Surguja, Matranga, 21.vi.2013, *A.P. Tiwari* 73185 (BSA).

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18. AN EXTENDED DISTRIBUTION OF *AMORPHOPHALLUS KONKANENSIS* HETT., S.R. YADAV & K.S. PATIL WITH NOTES ON ITS FLORAL VARIATIONS

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Introduction

The genus *Amorphophallus* Blume ex Decne. has about 200 species distributed in tropical Africa, Madagascar, tropical and subtropical Asia, Malay Archipelago, Melanesia, and Australia (Mayo *et al*. 1997). In India, the genus is represented by three sections, namely *Amorphophallus* Blume ex Decne., *Conophallus* (Schott), and *Rhaphiophallus* (Schott) Engl. The section *Rhaphiophallus* has 9 species, of which 8 are endemic to India, while the 9th, *A. sylvaticus*, has also been reported from Sri Lanka.

During our explorations in northern Kerala, we collected *Amorphophallus konkanensis*, which forms a new record for the state of Kerala. The specimens (Gholave & Yadav ARG-17) have been deposited in Shivaji University, Kolhapur.

The present communication reports an extended distribution of *Amorphophallus konkanensis* for Kerala with notes on diversity of neuters in the species.

Amorphophallus konkanensis Hett., S.R. Yadav & K.S. Patil, Blumea 39: 289–294. 1994.

Type: INDIA: Maneri, Sindhudurg District, 15.v.1992, *K.S. Patil* 4687- A.

Tuberous herb, tuber globose or depressed globose; leaf solitary; petiole smooth, 20–88 cm long, lamina 30–80 cm in diameter, rachis winged except for the most proximal parts; inflorescence with peduncle 20–35 cm long, spadix stipitate, spathe 6.5–14 cm long, green; female zone cylindric 0.6–1.5 cm long, flowers congested; male zone cylindric, 1.5–3.0 cm long; staminodes congested, rhomboid, slightly whitish or faintly purplish or dark purple; stigma 3-lobed. Fruits 2–4 seeded berries.

Chromosome number: 2n=26 (Lekhak and Yadav 2011; Patil 1995).

Flowering & Fruiting: April–June.

Distribution: Goa, Karnataka, Kerala, Madhya Pradesh, and Maharashtra (Fig. 1).

Specimens Examined: INDIA: Karnataka (Belgaum district): Pedekollimatti, 14.v.2013, *A.R. Gholave & S.R. Yadav* ARG-12. Kerala (Kasargod district): Periya village, 18.v.2013, *A.R. Gholave & S.R. Yadav* ARG-17. Madhya Pradesh (Khandwa district): Bhagpura, 7.vii.2012, *A.R. Gholave & S.K. Kamble* ARG 2. Maharashtra (Gondia district): Gondia, 13.vi.2013 *A.R. Gholave & A A. Adsul* ARG 31. All specimens deposited in SUK.

Notes: *Amorphophallus konkanensis*, an endemic to India, is widely distributed from Khandwa (M.P.) to northern Kerala. Characters of neuters in the genus *Amorphophallus* are of taxonomic value, however the species shows considerable variation in the neuters (Fig. 2). Specimens (Fig. 2a) collected from Kasargod district, Kerala (Fig. 1) show round orange neuters arranged in a single row, while specimens collected from Belgaum district, Karnataka (Fig. 2b) have round white neuters arranged in two rows. Similarly, specimens collected from Khandwa district, Madhya Pradesh (Fig. 2 c and d) have diamond-shaped tan coloured neuters arranged in two rows. Specimens collected from Sindhudurg district, Maharashtra (Fig. 2e), show diamond-shaped whitish-brown neuters arranged in two to four rows. Specimens collected from Gondia district, Maharashtra (Fig. 2f), have diamond-shaped maple coloured neuters arranged in three to five

Fig. 1: Geographical distribution of *Amorphophallus konkanensis*

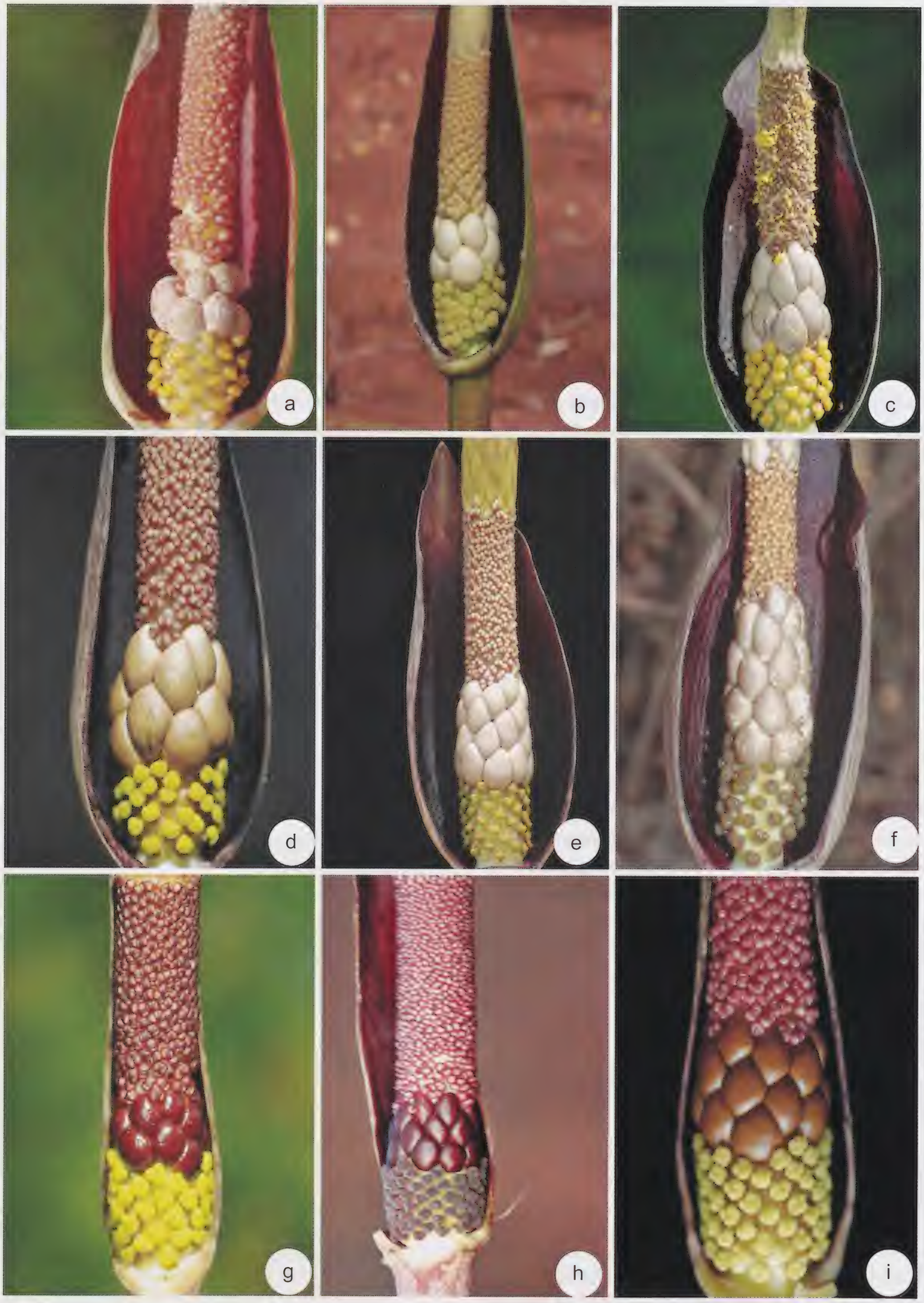

Fig. 2: Variation in neuter colour, shape, size and number in individuals of different populations of *Amorphophallus konkanensis* a: Kasargod, Kerala; b: Belgaum, Karnataka; c and d: Khandwa, Madhya Pradesh; e: Sindhudurg, Maharashtra; f: Gondia, Maharashtra; g–i: Kunkeshwar, Maharashtra.

rows. Specimens from Kunkeshwar, Maharashtra (Fig. 2 g–i) show round red neuters arranged in two to three rows. Hence, it can be concluded that the neuter colour can be white, tan, orange, maple, brown, or red. Similarly, neuter number can range from 10–25. The neuters show considerable variation in diameter, from 3–7 mm. Arrangement of neuters can range from 1–5 rows. However, variation in neuter morphology is accompanied by corresponding change in chromosome number or not is yet to be studied. So far 2n=26 is the only diploid number reported for *Amorphophallus konkanensis* (Lekhak and Yadav 2011; Patil 1995). A population-wise study of the species may reveal the presence of cytotypes.

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19. ADDITIONAL PLANT RECORDS FOR KARNATAKA, INDIA

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Introduction

During a study of the flora of Belgaum district of Karnataka (2005–2010), we collected specimens of *Ceropegia jainii* Ansari & B.G. Kulk. (Apocynaceae), *Eriocaulon tuberiferum* A.R. Kulk. & Desai (Eriocaulaceae), and three species of Poaceae, namely *Coelachne minuta* Bor, *Glyphochloa ratnagirica* (B.G. Kulk. & Hemadri) Clayton, and *Isachne borii* Hemadri. These five species have so far been reported to be endemic to Maharashtra state (Jagtap and Singh 1999; Karthikeyan *et al*. 1989; Mishra and Singh 2001). The collection of these species from Belgaum district indicates a range extension southwards in the Western Ghats and also forms a new record for the state of Karnataka. The voucher specimens are deposited at the herbarium of Botany Department (SUK), Shivaji University, Kolhapur.

Ceropegia jainii Ansari & B.G. Kulk. in *Bull. Bot. Surv. India 22(1–4)*: 221. 1980 (1982). (Apocynaceae)

Flowering & Fruiting: August–September.

Locality: Lateritic plateau at Sada village on the way to Kankumbi-Chorla.

Habitat: Open rocky places and in crevices of lateritic plateaux of higher altitude.

Threat Status: Critically Endangered (Mishra and Singh 2001).

Altitude: 812 m.

Exsiccata: NVM-3132.

Eriocaulon tuberiferum A.R. Kulk. & Desai in *J. Bombay Nat. Hist. Soc. 71(1)*: 81–84, t. 1974. (Eriocaulaceae)

Flowering & Fruiting: July–September.

Locality: Lateritic plateaux at Kankumbi and Amgaon.

Habitat: Occasionally found along the margins of temporary ponds and puddles on plateaux. Restricted to lateritic plateaux of higher altitude.

Threat status: Endangered (Mishra and Singh 2001).

Altitude: 806 m

Exsiccata: NVM-2909.

Note: Propagates through root tubers.

Coelachne minuta Bor in *J. Bombay Nat. Hist. Soc. 58*: 317. 1961. (Poaceae)

Flowering & Fruiting: August–October.

Locality: Lateritic plateaux at Sada, Kankumbi, and Amgaon.

Habitat: Open, rocky, moist grasslands, and wet places.

Threat status: Endangered (Mishra and Singh 2001).

Altitude: 808 m

Exsiccata: NVM-2910.

Note: Differs from other species of the genus by its minute spikelets.

Glyphochloa ratnagirica (B.G. Kulk. & Hemadri) Clayton in *Kew Bull. 35*: 815. 1981. (Poaceae)

Flowering & Fruiting: August–October.

Locality: Lateritic plateaux at Sada and Amgaon.

Habitat: Common on lateritic plateaux.

Threat status: Endangered (Mishra and Singh 2001).

Altitude: 807 m.

Exsiccata: ANC-931.

Note: Differs from other species of the genus by the lower glume of sessile spikelet only with marginal tubercles and pits on dorsal side. Grows in association with *Eriocaulon eurypeplon* Körn., *Danthonidium gammiei* (Bhide) C.E. Hubb., *Indopoa paupercula* (Stapf) Bor, *Fimbristylis microcarya* F. Muell. and *Pycreus sanguinolentus* (Vahl) Nees.

Isachne borii Hemadri in *Indian For. 97*: 233. 1971. (Poaceae)

Flowering & Fruiting: August–November.

Locality: Lateritic plateaux at Amgaon, Sada.

Habitat: Common on lateritic plateaux.

Threat status: Endangered (Mishra and Singh 2001).

Altitude: 811 m

Exsiccata: ANC-795.

Note: Can be identified by presence of dense woolly hairs at the base of the florets. Grows in association with *Eriocaulon eurypeplon* Körn., *Isachne pulchella* Roth, *Glyphochloa mysorensis* (Jain & Hemadri) Clayton, *Indopoa paupercula* (Stapf) Bor, *Fimbristylis microcarya* F. Muell. and *Pycreus sanguinolentus* (Vahl) Nees.

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